A STUDY OF GENETICS OF YIELD COMPONENTS IN BARLEY (*Hordium vulgare* L.)

THESIS

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CERTIFICATE

This is to certify that the thesis entitled, "A Study of Genetics of yield Components in Barley (Hordium vulgare L.)" submitted to the Bundelkhand University, Jhansi, as a partial fulfilment for the Degree of Master of Science in Agriculture (Genetics and Plant Breeding), is record of bonafide research work carried out by Shri Pavan Kumar under my supervision.

The thesis embodies the work of the candidate himself. The candidate worked under me in the academic session of 1991-92.

Dated : 30.8.92

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C O N T E N T S

****

GLOSSARY

C.F.	Correction Factor
Cms	Centrimeters
D.F.	Degree of Freédom
G.Ms.	Grams
M.S.	Mean Sum of Squares
M.S.P.	Mean Sum of production
N	Number of observation
	No. of replication
rg	Genotypic correlation coefficient
re	Environmental Correlation Coefficient
S.P.	Sum of Product
S.S.	Sum of Squares
V.R.	Variance Ratio
X	Varieties
Y	Yield
*	Significant at 5%

CHAPTER - I

INTRODUCTION

INTRODUCTION

Barley occupies fourth position in the world area under cereals and third in total cereal production. In odd conditions it gives better results the any other cereal, India stands seventh in total area as well as in production with barley in the world. The acreage and production of barley in India fluctuate between 1.99 to 3.45 million hectares and 2.00 to 3.25 millions tonnes respectively. The contribution of Uttar Pradesh is about 40 million hactares with a production of 1.2 millions tonnes with the introduction of high yielding varieties of barley and expension of irrigation facilities. The area under barley has shown declare trend of its cultivation has shifted to marginal lands.

Barley like wheat has a spike type of inflorescence, the barley spike has three spikelets per rachisnode, and each spikelet has a single florat. The barley spike terminator in a spikelet thus it is determinate in growth two distinct types of spikes are recognised in barley; six rows type and two rows type.

Barley is the most widely distributed cereal crop because of its tolerence to adverse climatic conditions. It is grown in all crop area from north to the south pole. It is well adopted to regions where other winter season crops are produced. Yield under dryland conditions supress

those of wheat, oat & rye. Barley tolerates high tempoerature is above 90°F under dry condition but to less tolerate of heat under conditions of high humidity. Thus barley is poorly adopted to the hot humidx nearly subtropical region of the south eastern united states.

Barley grows well on a fairly wide range of soil. It is best suited to heavier soil that have a high moisture holding capacity and a natural to slightly basic (pH between 7.00 - 8.00). Barley is the most saline soil tolerent of the cereal crops. Compared with other cereals it is also moderately drought and frost tolerent.

Barley grows in temperature ranging from 38° - 100°F during the vegetative stage of growth. The optimum temperature is the 70°F and during folowering the optimum temperature is 80°F and for germination the temperature must be between 40°F - 85°F. Seed maturation is favoured by warms day weather.

Genetic improvement is one of the avenues through increases in food production can be achieved to match population explosion in a developing country like India. The need of the hour is to embark upon verv exhaustive programm for maximum exploitation of the allele resources of our economic species, more so barley a crop of vast multitude of smells marginal farmers in minimum time

maximum exploitation of allele resource of a species involves synthesis of ideal genotypes possessing most useful allele of each gene, that has any ~~a~~ bearing of value of genotype. Phenotypic value in Agricultural species depends on various trials, most of which are multifactorial and incompletely heritable. Acknowledge of genotypic varience of population under study is it a major factor in the formation of appropriate breeding strategy for its improvement either through clawsical or recurrent selection method.

Although the knowledge of the correlation plays a very important role in guiding selection but it become anabiguous, it number of variables are more. In such a situation it is essential to partition the correlation coefficient into components of directs indirect effects in order to provide the relative importance of the causal factors. Under such situation path coefficient analysis developed by Wright (1921) is the only readily available tool in the hands of breeders which measures the actual contribution of such character.

Keeping in view, the above consideration the present investigation. "A study of genetics of yiled components in barley (Hordeum vulgare) was therefore undertaken to make an intensive study on the following aspects.

1. To estimate the Genotypic and phenotypic variabilities
2. To determine the nature and magnitude of genotypic and phenotypic correlation coefficients between yield and its contributing characters and among the characters themselves.
3. To identify the characters which have direct and indirect effect on grain yield with the help of path analysis.
4. Heritibility and genetic advance.

CHAPTER - II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A brief review of work done in breed barley and related crop for yield and its components which have direct relationship with the present study, is given below.

1. VARIABILITY :

Maluszynski, M. et al. (1883) observed that in a collection of 150 dwarf and semidwarf mutents, plant height was investigated in relation to stem, neck and ear length.

The possibólity of mutation affecting each of these features independently was demonstrated. Stem length showed the closest associationship with height, but tall plants with short stems were found. The association between height and each of the other traits was slight. In General, shorter plants agave lower grain yields. It is concluded that the selection, from collections of mutents, of fores which combine high yield with preference combinations of hight and other dimensions is a practical possibility.

Asthana, A.N. et al. (1984) observed that in 20 indigenous varieties of eleusine coracanna from Sikkim and 20 varieties selected from the all India co-ordinated varietal trial, Genotypic variance was found to be more important than error variance for days to flowering and maturity, plant height number of fingers on main tillers,

length of finger and grain yiled per plant. The genetic coefficient of variability was high for grain yield and finger length, which with days to flowering and maturity showed high broad-sense heritability estimates (92-98%). Estimates of genetic advance indicated that direct selection for yield would be most effective, followed by selection for finger length, day to flowering and maturity, number of fingers on the main tillers and plant height.

Wegrzym, S. et al. (1984), observed that the tall varieties cryf and MGZ. Ackerman were crossed reciprocally with each other and with two dwarf varieties, Diamant and colden promise, data on height, the length of the highest internode, the number of grains per ear, 1000 grain weight and grain weight in the main ear, recorded in the initial material and in the F_2 were analysed by several different methods. The dominance of greater height was establish, and the dominance or over dominance of a lower number of grain per ear, Broad-sense heritability was high (7.50 X) for height and 1000 grain weight in all crossed, but in MGZ Ackermen X Colden promise high values (57.6 - 66.9%) were obtained for all the characters studied.

Ceccarelli, S. et al. (1985) observed that in studies of ear to row progenes of 14 accessions of the spontaneous, there was significant genetic variation between and within

accessions for most of the characters studies (height, days to flowering, number of tillers, number of internodes, grain weight and reaction to <u>Rhynchosporium</u> <u>secalis</u> and <u>Puccinia hordia</u>). The amount of genetic variation within accessions also varied.

Ruiz, M.L. (1986) observed that the topic is reviewed under that following heading, collus types in barley varietion in chromosome number, chromosome number in plants regenerated from barley callus, and genetic variability through barley callus.

2. <u>HERITABILITY AND GENETIC ADVANCE</u> :

The concept of heritability is important to determine whether the phenotypic differences observed among various individuals are due to genetical change or the effect of invironmental factors. According to Luse (1940) heritability Board sense, it is the ratio of total genetic variances to phenotypic variance. In a narrow sense, it is the ratio of additive genetic variances to phenotypic variance.

Dudley, J.W. et al. (1967) Plant breeding programme can be divided in to three stage :

1. Creation of a pool of variable germ plasm.
2. Selection of superior individuals from the pool, and
3. Utilization of selected individuals to create a superior

variety. Estimates of genetic variance and heritability can be invitable in all the three stage. The methods for the estimation of heritability are parent off regressio: (Fisher 1918, Luse 1940, Robinson, et al. 1949). Variance components (Fishar 1918, Mathes 1949) use of genetically uniform population Luse 1948), use of F_2 and back cross proganies (Fray and Horner 1957) Constant parent regression (Criffing 1950), Component analysis (Rumpeckes and Allard 1952) and estimate of combining ability variance (Curnow 1961 et al.). Genetic advance or genetic grain is still a more useful estimate. It is important for genotypic value in new population, in constrast to the post population. The genetic grain depends upon.

The amount of genetic variability i.e. the megnitude of differences among different individual in the base population.

The magnitude of masking effect the environmental and interaction components of variability on the genetic diversity, and the intensity of selection (Comstock 1952)et al.).

The genetic grain is a product of heritability and selection differential expressed in term of phenotypic standard deviation of that characters. Heritability and genetic advance both are the components of direct selection it is necessary to utilize heritability, estimates in

conjugation with selection differential which would indicate the expected genetic grain, the work done on the heritability and genetic grain in barley by various workers is summarised as under.

Glass, R.L. et al. (1967) reported high heritability estimates for days to heading and plant height and low haritability for yield.

Borthakur, et al. (1970). Reported that haritability of Karnal weight was 25.8% to 23.9% and genetic advance ranged from 6.5 to 14.2% high heritability in broad-sense and high genetic advance for grain yield and grains per spike were reported by Sethi and Singh (1971).

Nasr et al. (1972) observed medium to high heritability for 1000 Karnel weight and plant height and slightly low for grain yield.

Herry and Yap (1972). Reported high heritability both for agronomical as well as morphological traits.

Studies of Acikgoz (1973) also confirmed that heritability was significant for plant highet, grain weight and grain per plant.

Abo-Fi-encin et al (1975) observed in all the combinations that differences between broad-sense and narrow sense heritability were fairly small expressed can of spikelets per spike.

Dixit, et al. (1979) reported high heritability for days to heading, plant height, spikelet per spike and grain yield. Expected genetic advance in percetage of mean was maximum for Tiller's per plant followed by plant height and grain yield.

Gulati and Murty, (1979). Reported high heritability for components traits, whereas, tiller's per plant, grain per spike and grain yield per plant bed low values.

Bainiwal, C.R. et al. (1984). Data are presented on the genetic components of variance for yield, Ear length and grain/earfrom an 8 x 8 half diallal studied at Hissar, Gene effects were note altered by treatment (drilling Vs spaced planning, cutting vs no catting).

Tong, Z.K. et al. (1984). In a study (1980-81) of 8 character's in 2 hybrid of six rowed barley and heading data hed the highest heritability value. Heritability for length of main ear, grain no. main ear differed significantly in the different hybrids, Heritability for heading data, length of main ear, grain number main ear and grain set of the trispikelete was higher in the two rowed hybrid and heritability for 1000 grain weight and ear number' per plant was highest in the six rowed hybrids. Expected genetic advance for ear number plant was relatively high in most of thehybrids and was positively correlated with the difference between the parents for all the characters.

Karim, M.A. and Yousif, N.K. (1986). Genetic variance data from work in Iraq for heights tiller number and grain yield and its compoents in the parental, F_1, F_2 and Back cross generations, of the H. distichon (Hordium valgare L.) crossed clippes x Bussele and A16 X aswad, Grain yield was mainly inflluenced by dominance and epistatic effects in A16 x asward and by additve and non-additive effects in clipper X bussele.

Singh, S.S. (1987). Days to 75% heading had the maximum direct effect on yield at the genotypic level and number of ear per plant at the phenotypic level in 11 varieties under irregated conditions in rainfed conditions ear length, number of ear per plant days to 75% maturity, Number of spikelets/spike and number of grain per spike exerted a direct effect on yield of the genotypic level while number of ear/spike and number of grains per spike hed the greatest effect at the phenotypic level, under lete sown conditions that grain yield was directly influenced by the number of grain per spike, plant hight days to 75% maturity and 1000 grain weight at the genotypic level and by all the character's except number of spikelet per spike of the phenotypic level. The expected genetic grains through selection using discriminant function were 17.4, 12.4 and 12.1% under irrigated rainfed and late sown conditions, respectively.

Singh, S.S. (1989). Yield and 8 yield component at pH 8.5-10.0 Heritability estimates and correlations among traits indicated that production tiller per plant day to flowering days to maturity and 200 grain weight would be the most useful selection criteria.

3. <u>CORRELATION AND PATH ANALYSIS</u> :

Tandon, J.P., Jain, K.B. and et al. (1968), expressed the genetic basis of the association between yield per plant, tiller/plant, grain/spike and 1000 karnel weight most of the association were found to be due to linkage, pleiotropy was established only in case of association between grain/ear and 1000 grain weight, environmental component of association were found to be considerable importance in several cases Corelation and Foote (1968) observed negative association of kernels head and weight of kernels.

Kulicenko, and et al. (1969). Reported a positive correlation between the 1000 kernels weight and grain/ear.

Usikova, A.A. (1969). The correlation and heritability and characters and spring barley. observed that the correlation between grain/ear and grain yield was higher then grain size and grain yield. Protein content was slightly related to grain size.

Nurty and et al. (1969). studied correlation coefficient between protein content and 1000 kernel weight, which was 0.68.

Sharma, D. (1970) observed that grain yield was positively and significantly associated with heading data. Plant height, productive tillers/plant, 1000 kernel weight and straw yield.

Sethi, G.S. and et al. (1971) observed that grain yield was positively correlated with spike per plant, grain/ spike and grain weight.

Nikitanka, G.B. (1972) found positive correlation in early hybrid generations between protein content and husk characters. High positive correlations were also observed by Singh and Singh (1973) for grain yield with grain/spike, productive tillers, spikeletes per spike and ear weight.

Singh, M. and et al. (1973). observation of ten yield characters in 30 varieties indicated that number of tillers and ear weight had the most influence on grain yield.

Morri, M.I. and et al. (1975). Studied that grain weight was positively associated with height but was independent of head number and spike length, while it was negative associated with spikelete per spike, height was

independent of head number but positively associated with both spike length and spikelets/p spike. head number was also positively associated with spike length, and spikelets per spike, strong positive correlation between grain/plant tillers/plant, grain weight and plant height were recorded by grafius and Cokli (1974), Jene (1976) and Nare and Khoyrallah (1976), Schols (1976) reported negative correlation between protein content and grain yield.

Samtha, I.M. and et al. (1979) observed negative correlation between grain weight and protein content.

Singh, R.B. and et al. (1979). revealed positive and significant correlation between harvest index and grain yield while harvest index had significant and negative association with days to heading, plant height and ear length.

Singh, S.K. and et al. (1979) observed that in a study of six characters in 60 indigenous and exotic genotypes grown in saline-alkali soil of p.H 8.5 the genotypic correlation of spike length, grain number per ear, number of ear bearing tillers and harvest index with grain yield per plant were positive where as that of plant height was negative. The number of ear bearing tillers showed the highest direct effect on grain yield per plant

followed by harvest index but these direct effects were reduced by the negative indirect effects of plant height spike length and harvest index on the number of ear bearing tillers, and plant height, spike length and number of ear bearing tillers on harvest index.

Reindergs, E. and park, S.J. et al. (1980) observed data from an experiment with 20 homozygous lines (DCC, PEA 9635) were reanalysed using a path coefficient method, Heading data, plant height, number of grain per plot and grain weight were more variable in hill plots then in row plots. The coefficient of variation for number of grain per spike were similar in both plot types. In hill plots over a range of environment and densities, this characters was more highly correlated with yield than any other. The analysis indicated the importance of the number of grain per spike as determinents of yield.

Tewari and Chandra (1980). Twenty five varieties from the Bichpuri college were grown in 1976-77 and 78 seven characters were examined by path coefficient analysis data are presented on the yield components that made the greatest contributions to grain yield of the genotypic and phenotypic levels in each year indicated that only spikelet number/spike, 250 grain weight and number of ear bearing tillers/plant contributed more directly to yield in both years.

Khodzhakulov, T. (1980) observed that the results are presented of analysis or correlation between yield components. The coefficient of correlation varied according to environmental condition and agronomic practices, but successfully used as the basis for selection for high yield, grain set and tillers number.

Glukhovtsev, V.V. (1982). In a study of 10 stable lines of different origin (100 plant each), a positive correlation was found between number of grain from the main ear and yield (r = 0.87 in drought years and r = 0.91 in wet years). Number of fertile tillers was correlated with grain wieght/plant (r = 0.93 in wet years and r = 0.49 in drought years), as was total tiller number (r = 0.61 under drought and r = 0.46 in wet conditions). It is concluded that proturely tillering froms may be better able to arthsland the unfavourable effect of drought and that is inadvisable to use varieties with weak tillering for breeding purposes.

Singh, R.R., Singh, R.V. and et al. (1983) Path coefficient of data on yield and 7 yield related characters in 32 varieties and this analysis in dicated significant differences between varieties for all characters. Number of grain per ear, test weight, ear length and days to flowering had the strongest correlation with yield.

Ayiecho, P.O. and et al. (1983). Grain yield, three yield components and grain nitrogen and mositure contents were investigated in a diallel cross with out reciprocals, invalving four two rowed and three six-rowed varieties. Grain yield per plant and ear per plant, were positively correlated in both ear row types. In the two rowed parents, ear per plant and grains per ear contributed significantly to grain yield. Negative correlations were observed between grain yield and grain N content and between grain weight and grain moisture content.

Babayan and et al (1984) observed that seeds of 14 winted barley cv. differing in grain protein contents were grown in rolls of damp filter paper and polythene film. A close correlation between linear growth, dry out, of 10 to 12 days old seed lings and grain protein content was observed ($r = + 0.7 - 0.8$).

Gupta S.C. and et al (1984) observed that in trials of 15 varieties grown on normal or saline soil, grain yield was strongly and positively correlated with number of tillers per plant and 1000 grain wieght on normal soil and with germination and number of tillers per plant on saline soil.

Kirtok, Y. and colkepen, M. (1985). path coefficient analysis based on phenotypic correlation coefficient obtained in 5 years, trail involving a total of 49 varieties was applied

to yield per plant and seven related trails. The components contributing directly to yield differed according to year but 1000 grain weight, ear length and number of grains/ear generally bad marked direct effect on yield.

Thomas, W.T.B. and et al. (1985). observed that phenotypic correlations were generally lower than the additive genetic correlations and occassionaly of different high yield per plant showed hight dominance genetic correlation with grain number and 1000 grain weight. Additive and dominance genetic correlations confirmed associations of the erectaides dwarfing gene with low 1000 grain weight and yield.

Palsson, H. (1987). ear per m^2, grain per ear and 1000 grain wieght were examined in about 300 spring barley breeding lines in 1987 and observed that all components showed considerable genetic variation in relation to environmental variation, but ears/m^2 was greatly affected by the environmental. The 1000 grain weight was closely correlated with yield ($r = 0.63$) probably because of lodging in many varieties resulted in poor grain filling, resistance to lodging shortly after heading was closely correlated ($r = 0.73$) with grain yield. The components were negatively correlated among themselves, making it difficult to identify one yield component to select it for yield improvement programe.

Singh, M.K., Pandey, R.L. and Singh, R.P. (1987). On a saline soil (Ec 45 ds/m) 60 naked grained lines were

evaluated for yield and its components. Yield were significantly correlated with number of productive tillers, plant hight and number of nodes/plant, days to heading and spike length had high and a positive direct effects on yield.

Larik, A.S. and et al (1987) correlation coefficient were calculated in all possible combinations between plant height, spike number, spikelesper spike, grain per spike and grain yield per ṗant in 5 cultivars spikelete per spike and grains per spike had a long positive association with grain yield. Path coefficient analysis and the computation of selection indices confirmed that spikelet per spike and grain per spike were the major components influencing grain yield and also indicated that selection based on these traits would be useful in producing high yielding cultivars.

Yadava H.S. and et al. (1988) path coefficient analysis of parents and F_1 of (Hordium vulgare L.) and results indicated that protein content and plumpness of grains, and protein content and 1000 grain weight had the greatest direct effects on grain yield in parents and F_1s respectively. In the parent & F_1s starch and crudefbre content of the grain, and plumpness in the latter case, showed direct positive effect on 1000 grain weight.

Kim, S.J., Chung, D.H. and et al. (1989). from the collection at the barley 131 lines were selected and subjected to principle components analysis, the first component seamed

to cresspond to culm length, spike length and own length, the second to days to heading and maturity and the IIIrd and foruth the to spike length and yield components The Q-correlation analysis assigned the lines to 11 groups.

CHAPTER - III

MATERIALS & METHODS

MATERIALS AND METHODS

MATERIALS :

Thirteen(13) varieties of barley (*Hordium vulgare* L.) was brought for the present investigation on the basis of their genetic diversity. They had been obtained from the C.S.A. University of Agriculture and Technology, Kanpur U.P. All the thirteen (13) varieties have been shown in the following table No. 1.

TABLE - 1

S.No.	Varieties	Symbol used
1.	K - 370	1
2.	K - 329	2
3.	Jyoti	3
4.	DL - 36	4
5.	K-257	5
6.	K - 71	6
7.	K - 273	7
8.	K - 226	8
9.	K - 252	9
10.	K - 318	10
11.	K - 366	11
12.	K - 169	12
13.	DL - 481	13

A) FIELD LAYOUT :

The material was sown in the complete randomized block design with three replication on November 13, 1991. Each treatment was sown in a plot of 2 rows each 4 meter long, spaced 50 cm apart. An approximate spaced of 5 cm. between the plant was maintained. The experiment was conducted at the college form of B.N. (PG) college Rath (Hamirpur) U.P.

B) CHARACTERS STUDIED :

The data on the following characters were recorded on 5 randomly choosen plants. In all 195 plant were tagged with the proper informations for identification.

Bordes rows were included from the experiment. During selection, however, the diseased and abnormal plants were avoided.

i) Days to flower (X_1)

ii) Height of plant (X_2)

The plant height was measured from bottom to top.

iii) Number of tillers per plant (X_3)

All the characters arising from the same node were committed.

iv) Length of ear (X_4)

v) No. of spikelete per spike (X_5)

vi) Days to maturity (X_6)

vii) No. of seed per ear (X_7)

viii) 100 seed weight (X_8)

ix) Yield per plant (X_9)

(C) STATISTICAL METHODS :

1) MEAN : it is the sum of measurements or observations divided by their number. Thus for each character the observation of 15 plants was averaged in accordance with the following formula.

$$\text{Mean} = \frac{SX}{N}$$

where

SX = Sum of all the observations

N = Number of observations

2) Analysis of variance : The procedure for analysis of variance of each character for randomized block design is as given below :

STEP - I :

First the variety total (T), the replication total (GT) were obtained in accordance with the following table - 2.

TABLE No. 2

Treatments	Replication			Total
1	X_{11}	X_{12}	X_{1n}	T_1
2	X_{21}	X_{22}	X_{2n}	T_2
3	X_{M1}	X_{M2}	X_{3n}	T_M
	R_1	R_2	R_n	(GT)

STEP - II

Calculation of sum of squares : The sum of squares were obtained following :

i) Correlation factor (C.F.) = $\frac{(GT)^2}{N}$

ii) Total sum of squares (T.S.S.)

$$(X_{11}^2 + X_{12}^2 + \ldots\ldots\ldots\ldots + X_{Mn}^2) - C.F.$$

iii) S.S. due to replication = $\frac{(R_1^2 + R_2^2 + \ldots\ldots + R_n^2)}{\text{Number of treatment}} - C.F.$

iv) S.S. due to treatment = $\frac{(T_1^2 + T_2^2 + \ldots\ldots\ldots + T_n^2)}{\text{No. of replication}} - C.F.$

v) S.S. due to error = T.S.S. (R.S.S. + T.S.S.)

STEP - III :

The sum of suqare were arranged in the following table to test the significants of differences between treatment.

TABLE NO. 3

S.No.	Source	D.F.	S.S.	M.S.S.	V.P.	F.value 5%	1%
1.	Replication	(R-1)	r	V_r			
2.	Treatment	(T-1)	t	V_t	Vt/Ve		
3.	Error	(R-1)(T-1)	e	V_e			
	Total						

If the variance ratio (V_t/Ve) for treatment lesser than the table value of 5 percent level of significance of the difference between treatment are considered to be not significant and viceversa.

Component of Variance :

Considering that all the varieties tested here were genetically uniform the expected mean sum of squares for error (M.Se), i.e. 6_e^2 will be purely random environmental varieties. The mean sum of squares between varieties will consist of the variances.

i) Attributable to varietal differences (Genotypic differences) and

ii) Due to environment.

Variation among individual of genotypic. Thus the expected mean of sum of square would be follows :

$$E\ (M.Sv) = 6_e^2 + r\ 6_g^2$$

$$E\ (M.Se) = 6_e^2$$

therefore, $6_g^2 = \frac{M.Sv - M.Se}{r}$

Phenotypic variance ($6_p^2 = 6_g^2 + 6_e^2$

TABLE NO. 4

S.No.	Components	6_g^2	6_e^2	6_p^2
1.	Days to flower			
2.	Height of plant			
3.	No. of tillers per plant			
4.	Length of ear			
5.	No. of spikelete per spike			
6.	Days to maturity			
7.	No. of seed per ear			
8	100 seed weight			
9.	yield per plant			

a) Coefficient of variation were calculated as follows :

$$\sqrt{\frac{6_p^2}{X}} \times 100$$

b) genotypic coefficient of variation (G.C.V.)

$$\sqrt{\frac{6_g^2}{\bar{X}}} \times 100$$

c) <u>Heritability (Broad sense)</u> :

It is the ratio of genetypic variance to phenotypic variance.

Formuña :

$$\text{Heritability} = (h^2) = \frac{6_g^2}{6_p^2}$$

d) <u>Analysis of covariance</u> :

The method of calculation different sum of products is given below :

i) Correction factor (C.F.) = $\frac{GT(X)\ GT(Y)}{N}$

ii) T.S.P. = $(X = X,\ X_{11}Y) + \_\_\_\_\_\_ + (X_{mn}X\ \ X_{mn})$

iii) R.S.P. $\frac{(R_1\ X\ R_2\ Y)+(R_2\ X\ R_2\ Y) + \ldots .(R_{mn}X, R_{mn}Y)}{\text{Number of replication}}$ – C.F.

iv) Error, S.P. = T.S.P. – (R.S.P. + T.S.P.)

<u>Component of covariance</u> :

Expectation of mean of sum of products follows the same principles as those mean sum of squares.

<u>Thus</u> :

$$E\ (M.SPv) = 6_{e_1}, e_2 + r_g^6\ \ 6_{g2}$$

$$E\ (M.SPe) = 6_{e1\ e2}$$

Hence :

$$6_{g1g2} = \frac{MSPv - MSPe}{r}$$

$$6_{p1p2} = 6_{g1g2} + 6_{e1e2}$$

These components were calculated and were summerised in the following table 5.

S.No.	Characters	Components		
		6_{g1g2}	6_{e1e2}	6_{p1p2}
1.	Days to flower vs. height of plant			
2.	Days to flower vs. No. of tiller per plant			
3.	Days to flower vs. length of ear			
4.	Days to flower Vs. No. of spikelet per spike			
5.	Days to flower Vs. Days to maturity			
6.	Days to flower Vs. No. of seed per ear			
7.	Days to flower Vs. 100 seed weight			
8.	Days to flower Vs. yield per plant			
9.	Height of plant Vs. No. of tiller per plant			
10.	Height of plant Vs. Length of ear per plant			

11. Height of plant Vs
No. of spikelet per plant

12. Height of plant Vs
days to maturity

13 Height of plant Vs
No. of seed per ear

14. Height of plant V/s
100 seed weight

15. Height of plant Vs
yield per plant

16. No.of tiller per plant Vs
length of ear

17. No. of tiller per plant Vs
No. of spikelet per spike

18. No. of tiller per plant Vs
Day to maturity

19. No. of tiller per plant Vs
No. of seed per ear

20. No. of tiller per plant Vs
100 seed weight

21. No. of tiller per plant Vs
yield per plant

22. Length of ear Vs. No. of
spikelet per spike

23. Length of ear Vs/ days
to maturity

24. Length of ear Vs

24. Length of ear Vs
    No. of seed per ear.

25. Length of ear Vs
    100 seed weight

26. Length of ear Vs.
    yield per plant

27. No. of spikelet per spike Vs
    Days to maturity.

28. No. of spikelete per spike Vs
    No. of seed per ear.

29. No. of spikelete per spike Vs
    100 seed weight

30. No. of spikelet per spike Vs
    yield per plant

31. Days to maturity Vs
    No. of seed per ear

32 Days to maturity Vs
   100 seed weight

33. Days to maturity Vs.
    Yield per plant.

34. No. of seed per ear Vs
    100 seed weight

35. No. of seed per ear Vs.
    Yield per plant

36. 100 seed weight Vs.
    yield per plant.

Correlation :

Corrèlation were calculated using the following formula :

$$r(X_1X_2) = \frac{Cov\ X_1X_2}{\sqrt{V\ (X_1).\ V\ (X_2)}}$$

where

$r = (X_1X_2)$ is the correlation between X_1 and X_2 Cov. (X_1X_2) is the covariance between X_1 & X_2.

$V\ (X_1)$ is the variance of X_1

$V\ (X_2)$ is the variance of X_2

ii) Correlation coefficients :

The correlation coefficient between the variable were computed with the help of formula :

A) Genotypic correlation coefficient :

Genotypic correlation coefficient was calculated by the following formula as suggested by Robinson et al. (1951).

$$\text{Genotypic correlation} = \frac{\text{Genotypic covariance}}{\sqrt{\text{G.V. for (X) X.G.V. for (Y)}}}$$

Where :

1. G.V. for X = Genotypic variance for X
2. G.V. for y = Genotypic variance for y

X and Y are two variables.

a) Genotypic covariance = $\frac{\text{M.S.P Treat.(XY)-M.S.P. error}}{r}$

b) Genotypic variance of X = $\frac{\text{M.S.S. Treat.(X)} - \text{M.S.S. error(X)}}{r}$

(B) Phenotypic correlation coefficient :

It was calculated by the following formula suggested by Robinson et al. (1951).

$$\text{Phenotypic correlation} = \frac{\text{Phenotypic covariance}}{\sqrt{\text{Ph.V. for (X) X Ph.V. for (y)}}}$$

where

Ph.V. for X = Phenotypic variance for X

Ph.V. for Y = Genotypic variance for y

X and y are two variables.

a) Phenotypic Covariance = $\frac{\text{M.S.P. Treat (XY)}}{r}$

b) Phenotypic variance of X = $\frac{\text{M.S.S. Treat (y)}}{r}$

c) Phenotypic variance of y = $\frac{\text{M.S.S. Treat (y)}}{r}$

(C) Environmental correlation coefficient :

Environmental correlation coefficient (re) was determined by the following formula :

$$re = \frac{\text{S.P. XY}}{\sqrt{\text{S.S.(X) X.S.S. (y)}}} \quad \text{(Error lines)}$$

where

re = Environmental correlation coefficient

S.P.(xy) = Sum of products of xy

S.P.(X) = Sum of square of X

S.P.(Y) = Sum of square of y

x and y are two variables.

Test of significance :

The significant of correlation coefficients was tested with the help of a table (Table VI) statistical tables by (Fishes and Yates), at n-2 degree of freedom.

Calculation of path coefficient :

In the figure abc and h are the path coefficient due to respective variables. Path coefficient can be defined as the ratio of the standard deviation of the effect due to a given cause to the total standard deviation of the effect i.e. if y is the effect and X_1 is the cause, the path coefficient for the path from cause X_1 to the effect y is X_1/y as per definition.

$\frac{6^2 X_1}{6y}$ = 'a' The path coeéfficient from X_1 to y

$\frac{6X_2}{6y}$ = 'b' The path coefficient from X_2 to y

$\frac{6X_3}{6y}$ = 'c' The Path coefficient from X_3 to y

Thus : $r(X_1 y) = a + r(X_1 X_2)\ b + r\ (X_1 X_3)\ C$

The correlation between X_1 and y may be partitional with three parts namely -

i) Due to direct effect of X_1 on y each amount to 'a'

ii) Due to indirect effect of X_1 on y Via X2 which amounts to r $(X_1 X_2)$ 'h' and

iii) Due to indirect eff2ct of X_1 on the via X_3 which equals

$$r = (X_1\ X_2)\ \text{'c'}$$

Thus :

We get the simultaneous equation -

$r(X_1 y) = a + r\ (X_1 X_2)\ b + r\ (X_1, X_3)\ C$

$r(X_2 y) = r\ (X_2 X_1)\ a + b + r\ (X_2, X_3)\ \text{'C'}$

$r(X_3 y) = r\ (X_3 X_1)\ a + r\ (X_3, X_2)\ b + C\ r\ (R.Y) = h$

It was used as follows :

$h^2 = 1 - a^2 - b^2 - c^2 - 2\ X(X_1\ X_2)\ ab\ 23(X_1 X_3)\ ac - 2\ r$
$(X_2 X_3)\ bc.$

$r_{14} = P_{14} + r_{12} + P_{24} + r_{13}\ P_{34}$

$$r_{24} = r_{21} P_{14} + P_{24} + r_{23} P_{34}$$

$$r_{34} = r_{31} P_{14} + r_{32} P_{24} + P_{34}$$

where

$$P_{14} = a, \; P_{24} = b, \text{ and } P_{34} = C,$$

The different path coefficient were calculated with the help of elimination procedure.

Residual effect :

It was calculated with the following formula :

$$1. \quad P^2_{R_4} + P^2_{14} + P^2_{24} + P^2_{34} + 2P_{14} r_{13} P_{34} + 2P_{24} r_{23}-P_{34}$$

or

$$1 = P^2_{R4} + P_{14} P_{14} + P_{24} r_{24} + P_{34} r_{34}$$

or

$$P_{R4} = \sqrt{1 - (P_{14}R_{14}) - (P_{24} r_{24}) - (P_{34} r_{34})}$$

Calculation of direct and indirect effects :

a) For (X_1) and (X_4)

Direct effect = P_{14}

Indirect effect via (X_2) = $P_{24} r_{12}$

Indirect effect via (X_3) = $P_{34} r_{13}$

b) for(X_2) and (X_1)

Direct effect = P_{24}

Indirect effect via (X_1) = $P_{14} r_{12}$

Indirect effect via $(X_3) = P_{34}\ r_{23}$

c) For (X_3) and (X_4)

Direct effect $= P_{34}$

Indirect effect via $(X_1) = P_{14}\ r_{13}$

Indirect effect via $(X_2) = P_{24}\ r_{24}$

These values were tabulated in the following table 6.

<u>Calculation of Genetic Advance</u> :

Genetic advance for each characters were calculated by the following formula -

$$G.A. = K \frac{g\ ww}{\sqrt{P\ Ww}}$$

Where,

gww = Genotypic variance of w

Pww = Phenotypic variance of w

K = Selection intensity at 5% (2.06)

w = character.

TABLE NO. 6

Direct and indirect effect of yield components on yield

S.No.	Character's	Days to flower	Height to plant	No. of tiller per plant	Length of ear	No. of spike let per spike	Days to maturity	No. of seed per ear	100 seed weight	Genotypic correlation with yield
1.	Days to flower									
2.	Height of plant									
3.	No. of tiller per plant									
4.	Length of ear									
5.	No. of spikelet per spike									
6.	Days to maturity									
7.	No. of seed per ear									
8.	100 seed weight									

CHAPTER - IV

EXPERIMENTAL FINDINGS

EXPERIMENTAL FINDINGS

Yield is a complex character's and therefore, selection can not be made if some other phenotypically distinguishable character's or character's are not positively associated with the yielding ability. The present experiment had been conduct3d to determine there character's who are directly or indirectly related to increase the grain yield.

Experiments conducted during the course of investigation included the following studies :

A) To estimate the genotypic and phenotypic variabilities.

B) To estimate the correlation coefficient among the character's.

C) Path analysis

D) Heritability and genetic advance

The results obtained from these studies are presented below :

Analysis of variance :

All the thirteen varieties used in this experiment were found highly significant for all the nine characters. On the basis of variability present in these materials, it is clear that the choice of the varieties was suitable for the estimation of selection parameters. Mean sum of square and variance ratios for all the nine characters has been

given in table No. 7.

A) <u>Estimation of genotypic and Phenotypic Variabilities</u> :

The genotypic, phenotype and environmental components of variance were calculated and they have been shown in the Table No. 8.

The genotypic variance of days to flower (24.66239) and hèight of plant (29.47160) were found high. The phenotypic variances of pàant of height (54.95650) were also found high whereas the other characters showed considerable variances. The high variances of the respective characters indicated about the dominant gene related for them and the low variances indicated about the relation of the respective characters with recessive genes with the phenotypic and genotypic variances. The respective variabilities had been calculated and they have been presentedin Table No. 9.

The genotypic variability of almost all characters were found considerable except that of days to maturity (6.98193). The No. of Tiller per plant (21.23762) and yield per plant (20.34365) showed the highest genotypic variability followed by Length of ear (9.38228). On the otherhand the phenotypic variabilities were also found satisfactory, specially yield per plant (34.89270), No. of Tiller per plant (25.69249), showed the high variability on the whole, these variabilities indicated that the selection

breeding programme with the help of these characters can be adopted. Table No. 10.

B) Estimation of the correlation coefficient :

Compoent of covariance were calculated for the different combinations of characters before the calculation of correlation coefficients. The genotypic, phenotypic and environmental covariance were calculated and they have been shown in Table No. 10.

Out of 36, 19 genotypic and 20 phenotypic covariance, were found positive, some of then were high which indicated about better association with these respective combinations of the characters Table No. 11.

a) Simple correlation :

Simple genetypic and phenotypic correlation of different pairs of characters had been calculated and they have been presented in table :

Out of 36, 10 combinations showed positive and significant result of correlation viz days to flower Vs No. of spikelet per spike (0.35592), height of plant vs days to maturity (0.99974), No. of Tiller per plant Vs yield per plant (0.46284), length of ear Vs No. of spikelet per spike (0.43982), length of ear days to maturity (0.35072). Length of ear Vs. No. of seed per ear (0.46157), length of ear vs yield per plant (0.71488), No. of spikelet per

spike Vs. No. of seed per ear (0.94150), No. of spikelete per spike Vs yield per plant (0.97531) No. of seed per ear Vs yield per plant (0.91496).

Out of 36, 15 combinations showed negative and significant result of correlation viz days to flower Vs Height of plant (-0.57977), Days to flower Vs No. of tiller per plant (-0.47482), Days to flower Vs. length of ear (-0.34167), Days to flower Vs. Days to maturity (-0.70556) Days to flower Vs. 100 seed weight (-0.48347), Height of plant Vs. No. of spikelete per spike (-0.56951), Height of plant Vs No. of Seed per ear (-0.98233), Height of plant Vs. yield per plant (-0.67055), Length of ear Vs. 100 seed weight (-0.34829), No. of spikelete per spike vs Days to maturity (-0.50395) No. of spikelete per spike Vs 100 seed weight (-0.74082), Days to maturity Vs. No. of seed per ear (-0.81155), days to maturity Vs yield per plant (-0.86339) No. of seed per ear Vs 100 seed weight (-0.99806). 100 seed weight Vs yield per plant (-0.99522).

b) <u>Correlation of characters with yield</u> :

1. <u>Positive and significant correlation with yield</u> :

Following characters showed positive and significant correlations with yield.

No. of tiller per pàant (0.46284), length of ear (0.71488), No. of spikelete per spike (0.97.531), No. of

seed per ear (0.91436).

2. Negative and significant correlation with yield :

Following characters were found Negatively significantly correlated with yield.

Height of plant (-0.67055), 100 seed weight (-0.93522), Days to maturity (-0.86339).

3. Positive and significant correlation among the characters :

Following combination of character's were found positive and significant. Days to flower and No. of spikelet per spike (0.35592), length of ear and no. of spikelete per spike (0.43982), length of ear and Days to maturity. (0.35072), length of ear and No. of seed per ear (0.46157), No. of spikelet per spike and No. of seed per ear (0.94150).

4. Negative and significant correlation among the characters :

Following combination of character were found Negative and significant.

Days to flower and height of plant (-0.57977), Days to flower and No. of tiller per plant (-0.47482), Days to flower and length of ear (-0.34167), Days to flower and Days to maturity (-0.70556) Days to flower and 100 seed weight (-0.48341), Height of plant and No. of spikelet per spike

(-0.56951), Height of plant and No. of seed per ear (-0.98233), Length of ear and 100 seed weight (-0.34829) No. of spikelet per plant and Days to maturity (-0.50395), No. of spikelet per spike and 100 seed weight (-0.74082), Days to maturity and No. of seed per ear (-0.81155) No. of seed per ear and 100 seed weight (-0.99806),

5. Non significant correlation among the characters :

Following combination of characters were found positive or negative and non significant.

Days to flower and No. of seed per ear (0.25598), Days to flower and yield per plant (0.08491), Height of plant and No. of Tiller per plant (0.01078), Height of plant and length of ear (0.28563), Height of plant and 100 seed weight (-0.24441), No. of tiller per plant and length of ear (0.19358), No. of tillers per plant and No. of spikelete per spike (0.08358), No. of Tiller per plant and Days to maturity (0.05060), No. of Tiller per plant and No. of seed per ear (0.14532), No. of Tillers per plant and 100 seed weight (0.13486), Days to maturity and 100 seed wieght (-0.29927) Table No. 12.

C. Path analysis (Direct and indirect effect of yield components on yield) :

The path coefficient was carried out to partition the observed relationship between yield and its compoents into

direct and indirect effects. The observed total genotypic correlation coefficient between yield and its components was partitioned into direct and indirect effects, the estimates of direct and indirect effect are presented in table No. 13.

The result of path analysis showing effect and causation of eight characters on average yield per plant in (*Hordium vulgare* L.) are described below :

1. Height of plant Vs Yield per plant :

Negative and significant correlation value of height of plant showed true genetic associationship with yield per plant (-0.67055). The direct effect of Height of plant on yield was found Negative (-2.28281) with high magnitude. Indirect effect of height of plant via No. of seed per ear (-1.93761), Height of plant via Days to flower (-0.47502), were found nagative. The indirect effect of height of plant via No. of tillers per plant (0.00702), Height of plant via length of ear (0.39597), Height of plant via No. of spikelet per spike (1.96719), Hight of plant via Days to maturity (1.45971), Height of plant via 100 seed wieght (0.19499) were found positive.

2. No. of tiller per plant Vs yield per plant :

Positive and significant correlation value of No. of Tiller per plant with yield showed true genetic associationship

with yield per plant (0.46284). The direct effect of No. of tiller per plant on yield was found positive (0.65061) with High magnitude. Indirect effect of No. of tiller per plant via days to flower (-0.38903), No. of tiller per plant via Height of plant (-0.02462), No. of tiller per plant via No. of spikelete per spike (-0.28869) No. of tiller per plant via 100 seed weight (-0.10759) were found negative, the indirect effect of No. of tiller per plant via length of ear (0.26837), No. of tiller per plant via days to maturity (0.06716), No. of tiller per plant via No. of seed per ear (0.28663) were found positive but how in magnitude.

3. Length of ear per plant Vs yield per plant :

Positive and significant correlation value of length of ear with yield showed true genetic associationship. The direct efeect of length of ear on yield was found positive with high magnitude. Indirect effect of length of ear via days to flower (-0.27994), length of ear via height of plant (-0.65204), length of ear via No. of spikelet per spike (-1.51920) were found negative, The indirect effect of length of ear via No. of tiller per plant (0.125950), Length of ear via days to maturity (0.46552), length of ear via No. of seed per ear (0.91042) length of ear via 100 seed weight (0.27786) were found positive.

4. <u>No. of spikelet per spike Vs yield per plant</u> :

The genotypic correlation of No. of spikelet per spike Vs yield per plant was found positive and significant (0.97531) which indicated the true relationship between these two characters.

The direct effect of No. of spikelet per spike (-3.45418) was found negative but high in magnitude.

The indirect effect of this characters via days to maturity (-0.66891) were found negative but the indirect effect via Days to flower (0.29116), height of plant (1.30008) No. of tiller per plant (0.05438), length of ear (0.60792), No. of seed per ear (2.25158), 100 seed weight (0.59103) were found positive.

5. <u>Days to maturity Vs yield per plant</u> :

The genetic correlation of days to maturity vs yield per plant was found negative and significant (-0.86339) which indicated the true relationship between these two characters.

The direct effect of days to maturity (1.32732), was found positive and high in magnitude.

The indirect effect of this characters via days to flower (-0.57808) Height of plant (-2.51050), No. of seed per ear (-~~2~~1.6007) were found negative but the indirect effect via No. of tiller per plant (0.03292), length of ear

(0.48621), No. of spikelet per spike (1.74074) 100 seed weight (0.23878), were found positive.

6. <u>No. of seed per ear Vs Yield per plant</u> :

The genotypic correlation of No. of seed per ear Vs yield per plant (0.99496) was found positive and significant which indicated the true relationship between these two characters.

The direct effect of No. of seed per ear (1.97247) was found positive and high in magnitude.

The indirect effect of this character via No. of spikelet per spike (-3.94297), days to maturity (-1.07719) were found negative but the indirect effect via Days to flower (0.20973), height of plant (2.24246) No. of tiller per plant (0.09454), length of ear (0.63989) and 100 seed weight (0.87604) were found positive.

7. <u>100 seed weight Vs yield per plant</u> :

The genotypic correlation of 100 seed weight Vs. yield per plant (-0.93522) was found Negative and significant which indicated the true relationship between these two characters.

The direct effect of 100 seed weight (-0.79781) was found negative but low in magnitude. The indirect effect of this character via days to flower (-0.39607); length of

ear (-0.48283), Days to maturity (-0.39723), No. of seed per ear (-0.16589), were also found negative but the indirect effect via height of plant (0.55795) No. of tiller per plant (0.08774) and No. of spikelet per spike (2.55892), were found positive.

D) Heritability and Genetic advance :

Among all nine characters days to flower (82.56080), Height of plant (53.62715), No. of tiller per plant (68.32810), length of ear (68.83229) and No. of spikelet per plant (68.18720), showed high heritability i.e. more than 50% other character showed medium heritabilities (i.e. between 30-50%).

The genetic advance of each characters were found low. High heritability and low genetic advance ~~idm~~ indicated about the better choice of selection through these traits. Table No. 14.

TABLE NO. 7

ANOVA for different character's

S.No.	Character's	S.S.		M.S.S.		F.Value
		Block	Treatment	Block	Treatment	
1.	Days to flower	16.97436	950.35897	8.48718	79.19658	15.203*
2.	Height of plant	111.01590	1366.79641	55.50795	113.89970	4.469*
3.	No. of titler per plant	0.61744	78.89026	0.30872	6.57419	7.472*
4.	Length of ear	0.08681	18.64319	0.04340	1.55360	7.625*
5.	No. of spikelet per spike	0.65949	103.81294	0.32475	8.65108	7.430*
6.	Days to maturity	1.58974	92.92308	0.79487	7.74359	2.411 *
7.	No. of seed per ear	8.36794	593.60930	4.18397	49.46744	2.255*
8.	100 seed weight	0.28347	6.66384	0.12173	0.55532	2.329*
9.	Yield per plant	9.55241	429.81183	4.77620	35.81765	2.545*

*Significant at 5% level.

TABLE NO. 8

Component of Covariance

S.No.	Character	Genetypic Cov ($6g_1g_2$)	Phenotypic Cov.($6_{p1}P_2$)	Environ-mental Cov.($6e_1e$
1.	Days to flower Vs Height of plant	-15.53066	-16.25983	-0.62917
2.	Days of flower Vs No. of Titles per plant	-3.24882	- 2.64444	0.60427
3.	Days to flower Vs Length of ear	-1.13817	- 1.26261	-0.12443
4.	Days to flower Vs No. of spikelet per spike	2.79226	3.10940	0.31714
5.	Days to flower Vs. Days to maturity	-4.30662	- 3.54060	0.76603
6.	Days to flower Vs No. of seed per ear	3.85105	4.89002	1.03897
7.	Days to flower Vs. 100 seed weight	-0.79029	- 0.43327	0.34702
8.	Days to flower Vs Yield per plant	1.13521	3.67863	2.54342
9.	Height of plant Vs No. of Titler per plant	0.08066	- 0.41338	-0.49404
10.	Height of plant Vs Length of ear	1.04014	1.68411	0.64397
11.	Height of plant Vs No. of spikelets per spike	-4.88415	- 3.82238	1.06177
12.	Height of plant Vs Days to maturity	7.33803	10.07201	2.73397

13.	Height of plant Vs. No. of seed per ear	-16.15543	-2.85534	13.30009
14.	Height of plant Vs. 100 Seed Weight	- 0.43127	0.34282	0.77409
15.	Height of plant Vs Yield per plant	- 9.80036	0.03161	9.83196
16.	No. of Tiller per plant Vs. Length of ear	0.17890	0.26895	0.09005
17.	No. of Tiller per plant Vs No. of spikelet per spike	0.18190	0.36975	0.18785
18.	No. of Tiller per plant Vs Days to maturity	0.08568	0.23846	0.15278
19.	No. of Tiller per plant Vs No.of seed per ear	0.60651	0.12291	-0.48360
20.	No. of Tiller per plant Vs 100 seed weight	0.06039	-0.07431	-0.13470
21.	No. of Tiller per plant Vs Yield per plant	1.71681	2.88229	1.16553
22.	Length of ear Vs. No. of spikelet per spike	0.46606	0.72515	0.25909
23.	Length of ear Vs. Day to maturity	0.28916	0.11158	-0.17757
24.	Lenth of ear Vs. No. of seed per ear	0.93795	1.65130	0.71335
25.	Length of ear Vs. 100 seed weight	-0.07593	-0.06679	0.00915
26.	Length of ear Vs. Yield per plant	1.29099	1.38057	0.08959

27.	No. of spiketet per spike Vs. Day to maturity	-0.97850	-1.16468	-0.18618
28.	No. of spikelet per spike Vs. No. of seed per ear	5.46292	6.47551	1.01259
29.	No. of spikelet per spike Vs. 100 seed weight	-0.38038	-0.34692	0.03346
30.	No. of spikelet per spike Vs. Yield per plant	4.14797	5.17010	1.02213
31.	Days to maturity Vs. No. of seed per ear	-3.02179	-0.30844	2.71335
32.	Days to maturity Vs. 100 seed weight	-0.11956	-0.03285	0.08670
33.	Days to maturity Vs. Yield per plant	-2.85693	1.06600	3.92294
34.	No. of seed per ear Vs. 100 seed weight	-1.08120	-0.34941	0.73179
35.	No. of seed per ear Vs. Yield per plant	8.27779	14.93945	6.66166
36.	100 seed weight Vs. Yield per plant	-0.90585	-0.20339	0.70242

TABLE NO. 9

Components of Variance

S.No.	Characters	${}^{2}g$	${}^{2}p$	${}^{2}e$
1.	Days to flower	24.66239	29.87179	5.20940
2.	Height of plant	29.47160	54.95650	25.48489
3.	No. of tiller per ppant	1.89812	2.77795	0.87983
4.	Lenght of ear	0.44995	0.65369	0.20374
5.	No. of spikelet per spike	2.49559	3.65991	1.16432
6.	Days to maturity	1.51064	4.72222	3.21154
7.	No. of seed per ear	9.17745	31.11254	21.93509
8.	100 seed weight	0.10564	0.34404	0.23899
9.	Yield per plant	7.24791	21.32182	14.07391

TABLE NO. 10

Genotypic and phenotypic coefficient of variability

S.No.	Character's	G.C.V.	P.C.V.
1.	Days to flower	6.98193	7.68403
2.	Height of plant	5.07532	6.93061
3.	No. of tiller per plant	21.23762	25.69249
4.	Length of ear	9.38228	11.30869
5.	No. of spikelet per spike	8.54875	10.35264
6.	Days to maturity	0.95946	1.69635
7.	No. of seed per ear	6.20697	11.42842
8.	100 seed weight	7.22406	13.03656
9.	yield per plant	20.34365	34.89270

TABLE NO. 11

Sample Genotypic Correlation

S.No.	Characters	Correlation
1.	Days to flower Vs. Height of plant	-0.57977*
2.	Days to flower Vs. No. of tiller per plant	-0.47482*
3.	Days to flower Vs. Length of ear	-0.34167*
4.	Vs. No. of spikelet per spike	0.35592*
5.	Vs. Days to maturity	-0.70556*
6.	Vs. No. of speed per ear	0.25598
7.	Vs. 100 seed weight	-0.48341*
8.	Vs. yield per plant	0.08491
9.	Height of plant Vs. No. of Tiller per plant	0.01078
10.	Vs. Length of ear	0.28563
11.	Vs. No. of spikelet per spike	-0.56951*
12.	Vs. Days to maturity	0.99974*
13.	Vs. No. of seed per ear	-0.98233*
14.	Vs. 100 seed weight	-0.24441
15.	Vs. yield per plant	-0.67055*
16.	No. of Tiller per plant Vs. Length of ear	0.19358
17.	Vs. No. of spikelet ear	0.08358

18.		Vs. Days to maturity	0.05060
19.		Vs. No. of seed per ear	0.14532
20.		Vs. 100 seed weight	0.13486
21.		Vs. yield per plant	0.46284*
22.	Length of ear	Vs. No. of spikelet per spike	0.43982*
23.		Vs. Days to maturity	0.35072*
24.		Vs. No. of seed per ear	0.46157*
25.		Vs. 100 seed weight	-0.34829*
26.		Vs. yield per plant	0.71488*
27.	No. of spikelet per spike	Vs. Days to maturity	-0.50395*
28.		Vs. No. of seed per ear	0.94150*
29.		Vs. 100 seed weight	-0.74082*
30.		Vs. Yield per plant	0.97531*
31.	Days to maturity	Vs. No. of seed per ear	-0.81155*
32.		Vs. 100 seed weight	-0.29927
33.		Vs. yield per plant	-0.86339*
34.	No. of seed per ear	Vs. 100 seed weight	-0.99806*
35.		Vs. yield per plant	0.91496*
36.	100 seed weight	Vs. yield per plant	-0.99522*

*Significant at 5% level.

TABLE NO. 12

GENOTYPIC AND PHENOTYPIC CORRELATION COEFFICIENTS

S.No.	Character		Days of flower-ing	Height of plant	No. of Tiller per plant	Length of ear per plat	No. of spikelet per plant	Days to maturity	No. of seed ear	100 seed weight	Yield per plant
1.	Days to flower	G		-0.57977*	-0.47482*	-0.34167*	0.35592*	-0.70556*	0.25598	-0.48341*	0.08491
		P		-0.40131*	-0.29030	-0.28573	0.29738	-0.29811	0.16040	-0.13515	-0.14576
2.	Height of plant	G			0.01078	0.28563	-0.56951*	0.9974 *	-0.98233*	-0.24441	-0.67055*
		P			-0.03346	0.28098	-0.26952	0.62522*	-0.06905	0.07884	0.00092
3.	No. of Tiller per plant	G				0.19358	0.08358	0.05060	0.14532	0.13486	0.46284*
		P				0.19958	0.11596	0.06584	0.01322	-0.07601	0.37451*
4.	Length of ear	G					0.43982*	0.35072*	0.86157*	-0.34829*	0.71488*
		P					0.46882*	0.06351	0.36166*	-0.14083	0.36979*
5.	No. of spikelet per spike	G						-0.50395*	0.94150*	-0.74082*	0.97531*
		P						-0.28015	0.60684*	-0.30917	0.58926*
6.	Days to maturity	G							-0.81155*	-2.29927	-0.86339*
		P							-0.02545	- .02577	0.10624
7.	No. of seed per ear	G								-0.99806*	0.91496*
		P								-0.10680	0.58004*
8.	100 seed weight	G									-0.93522*
		P									-0.07509
9.	yield per plant	G									
		P									

TABLE NO. 13

Direct and indirect effect of yield components on yield

S.No.	Character's	Days of flowers	Height of plant	No. of Tiller per plant	Length of ear	No. of spikelet per spike	Days to maturity	No. of seed per ear	100 seed weight	Genotypic correlation wit yield
1.	Days to flower	0.81932	1.32351	-0.30892	-0.47366	-1.22941	-0.93650	0.59491	0.38567	0.08491
2.	Height of plant	-0.47502	-0.28281	0.00702	0.39597	1.96719	1.45971	-1.93761	0.19499	-0.67055*
3.	No. of tiller per plant	-0.38903	-0.02462	0.65061	0.26837	-0.28869	0.06716	0.28663	-0.10759	0.46264*
4.	Lenght of ear	-0.27994	-0.65204	0.12595	1.38631	-1.51920	0.46552	0.91042	0.27786	0.71488*
5.	No. of spikelet per spike	0.29161	1.30008	0.05438	0.60972	-3.45418	-0.66891	2.25158	0.59103	0.97531*
6.	Days to maturity	-0.57808	-2.51050	00.03292	0.48621	1.74074	1.32732	-1.60076	0.23836	-0.86339*
7.	No. of seed per ear	0.20973	2.24246	0.09454	0.63989	-3.94297	-1.07719	1.97247	0.87604	0.99496*
8.	100 seed weight	-0.39607	0.55795	0.08774	-0.48203	2.55892	-0.39723	-2.16589	-0.79781	-0.93522*

Residual effect = ± 0.20545255

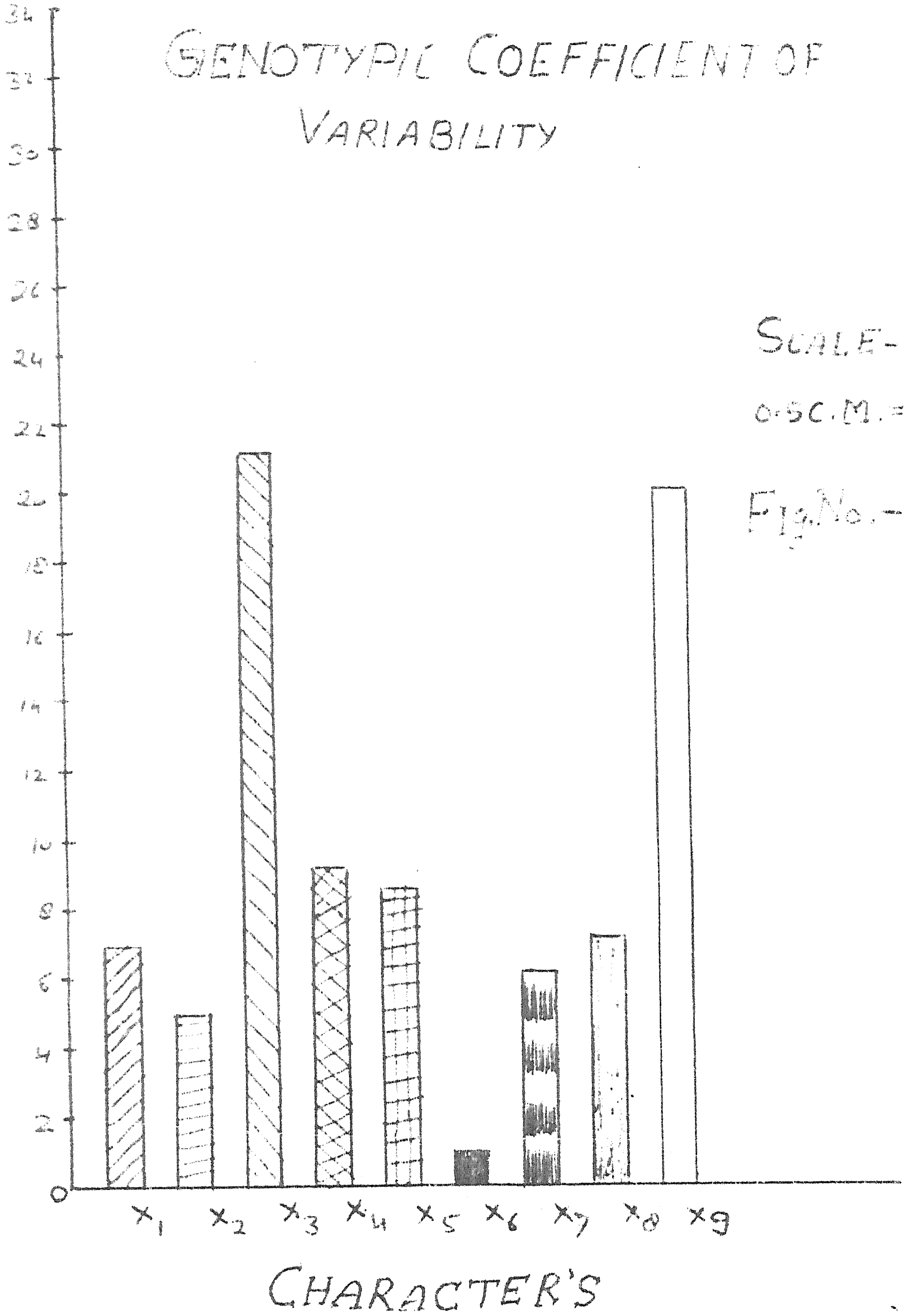
Underlined figures divide direct effects

*Significant of 5% level

TABLE NO. 14

Heritability and Genetic advance

S.No.	Character's	Heritibility %	Genetic advance %
1.	Days to flower	82.56080	9.29548
2.	Height of plant	53.62715	8.18958
3.	No. of tiller per plant	68.32810	2.34600
4.	Length of ear	68.83229	1.14643
5.	No. of spikelet per spike	68.18720	2.68723
6.	Days to maturity	31.99095	1.43208
7.	No. of seed per ear	29.49759	3.38939
8.	100 seed weight	30.70694	0.37103
9.	yield per plant	33.99293	3.23346



SCALE-
0.5 C.M. = 1 Value

Fig. No. - 1

PHENOTYPIC COEFFICIENT OF VARIABILITY

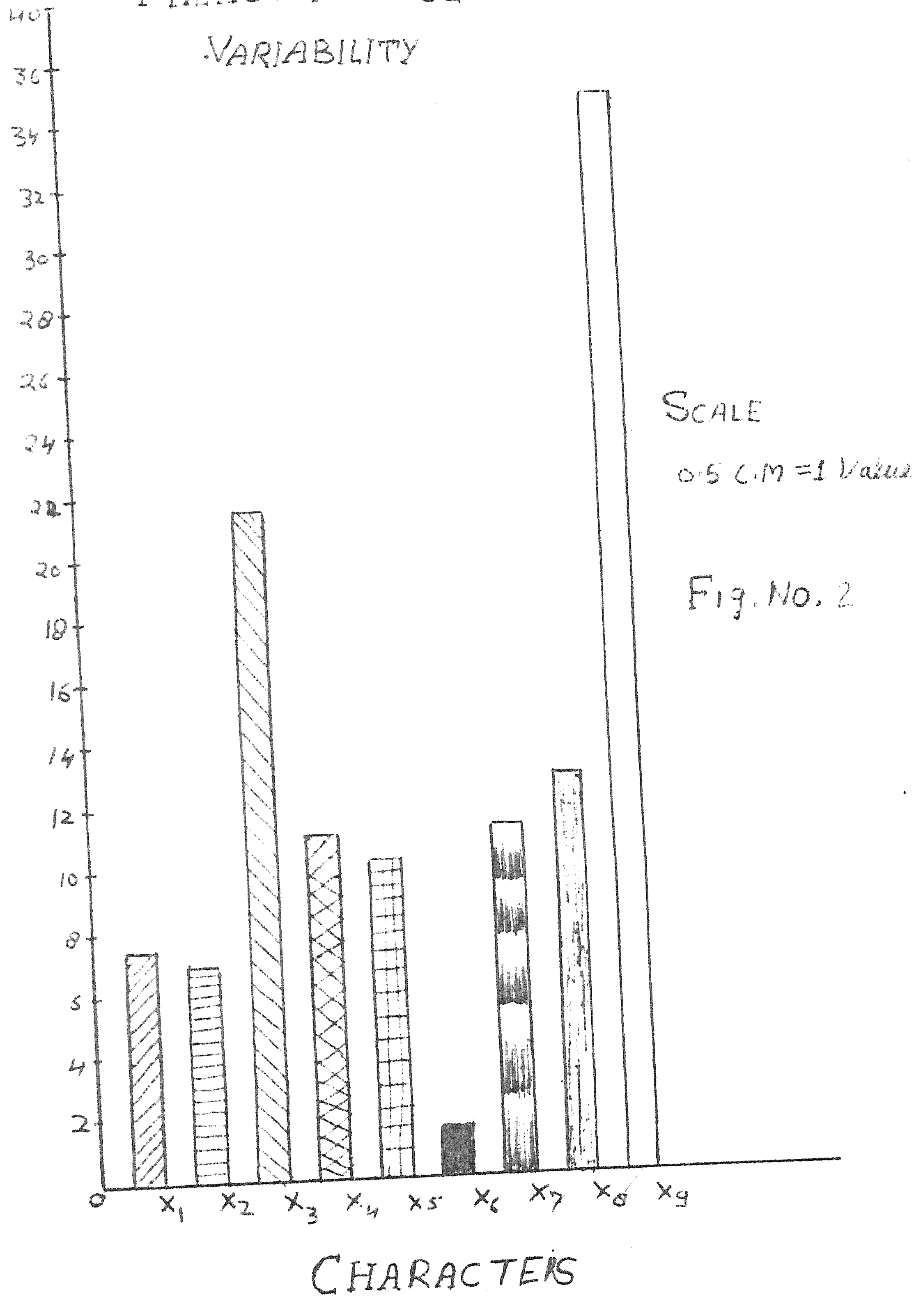
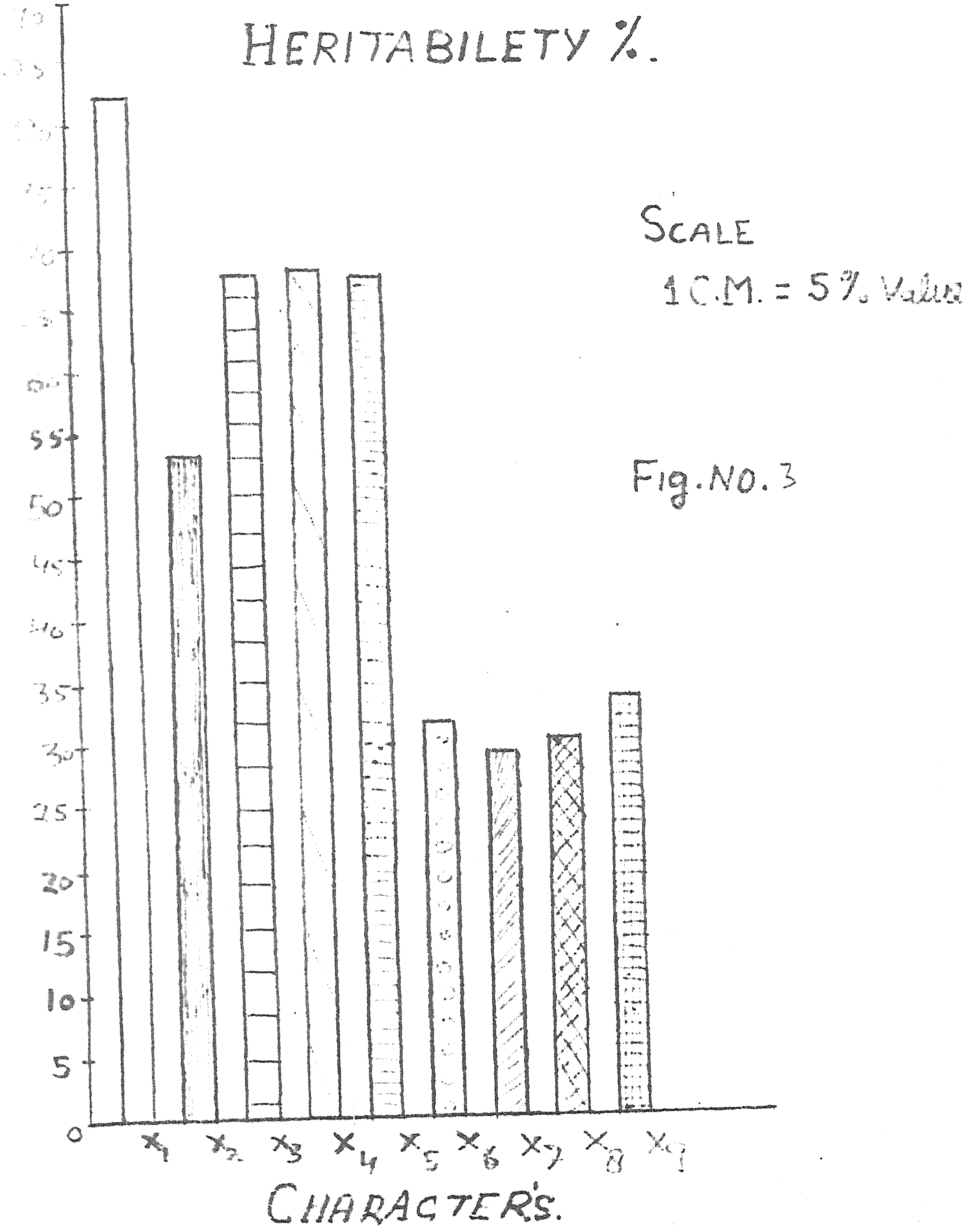


Fig. No. 2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SCALE
1 C.M. = 5 % Value
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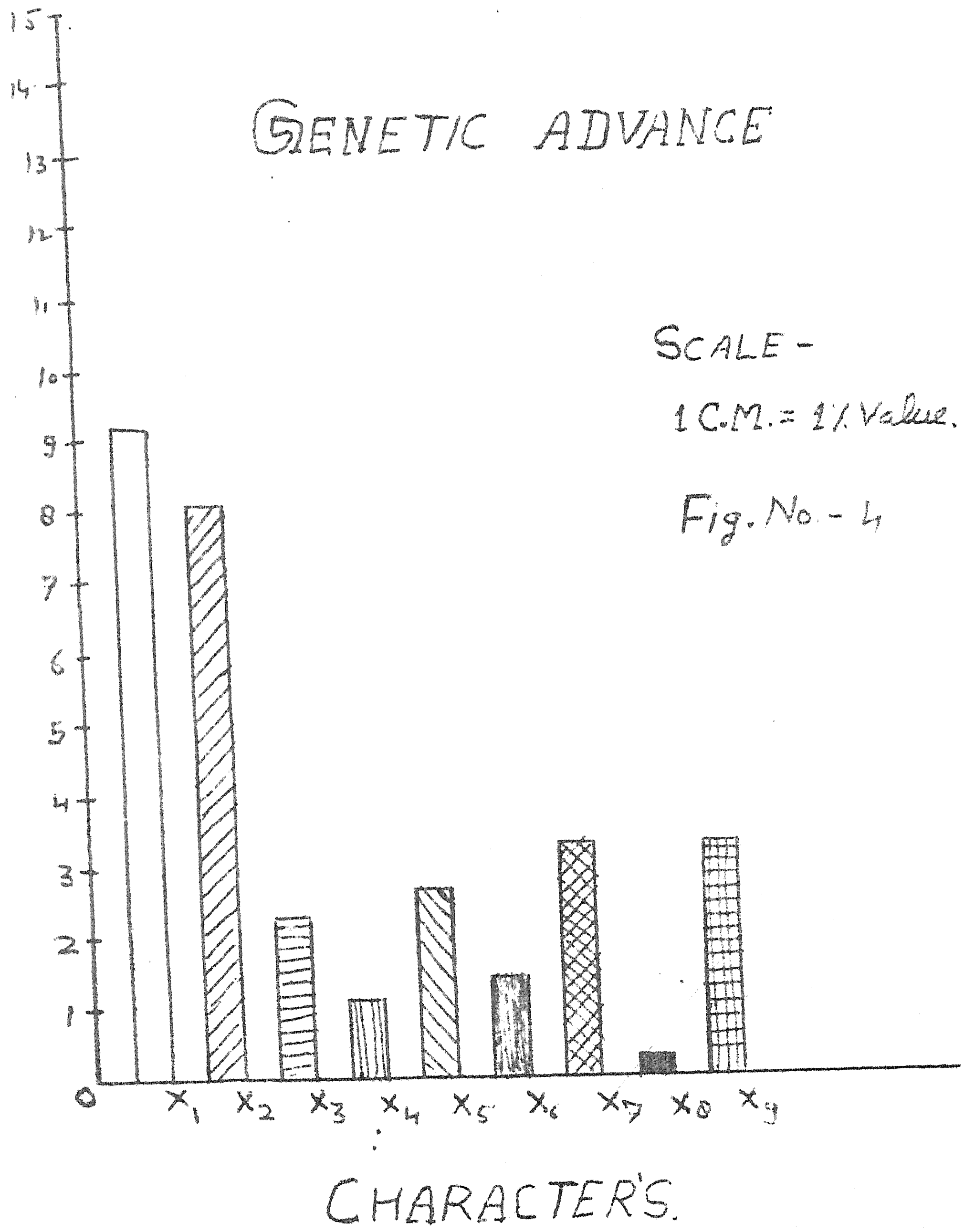
50
45
40
35
30
25
20
15
10
5
0
x_1 x_2 x_3 x_4 x_5 x_6 x_7 x_8 x_9
CHARACTER'S.

Fig. No. 3


GENETIC ADVANCE
SCALE -
1 C.M. = 1% Value.
Fig. No. - 4
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
X1
X2
X3
X4
X5
X6
X7
X8
X9
CHARACTER'S.

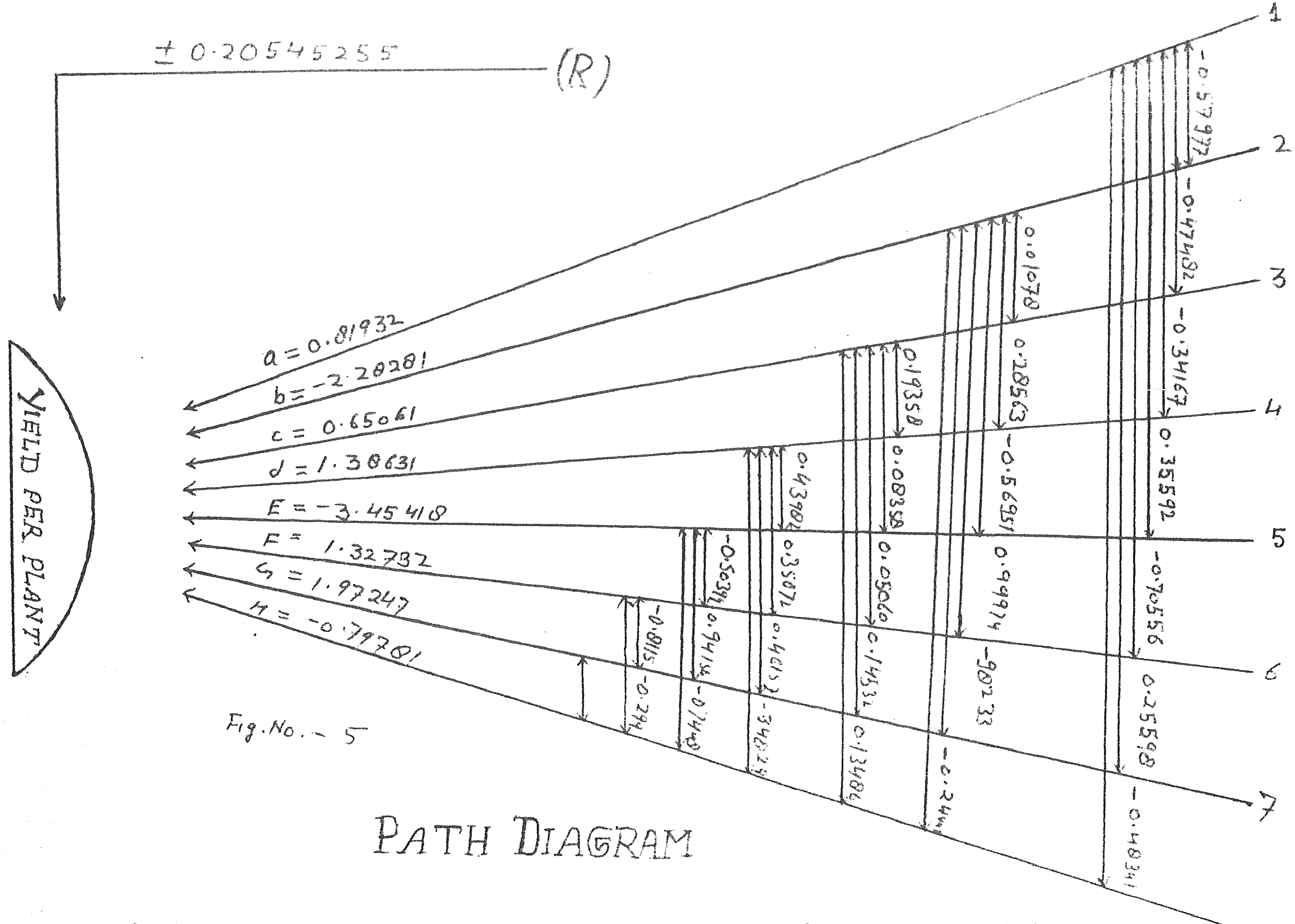
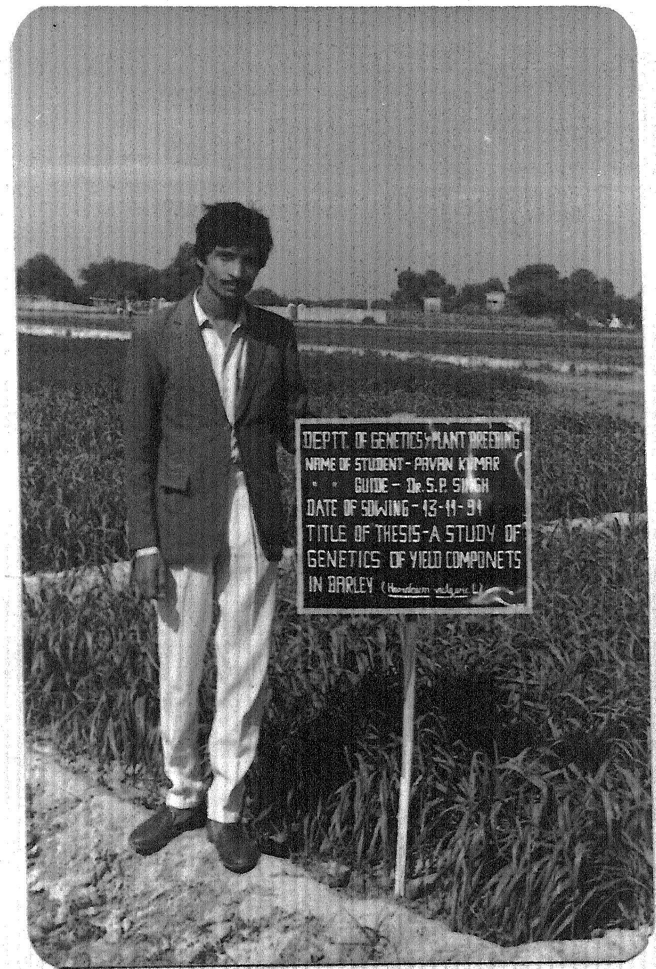


Fig. No. - 5

PATH DIAGRAM

SHOWING CAUSE AND EFFECT RELATIONSHIP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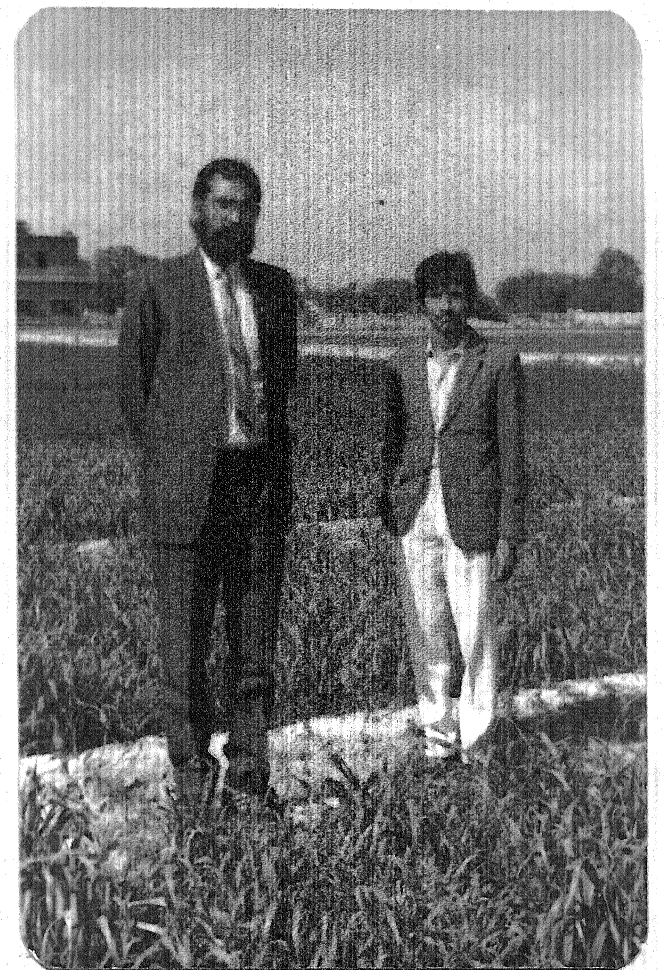
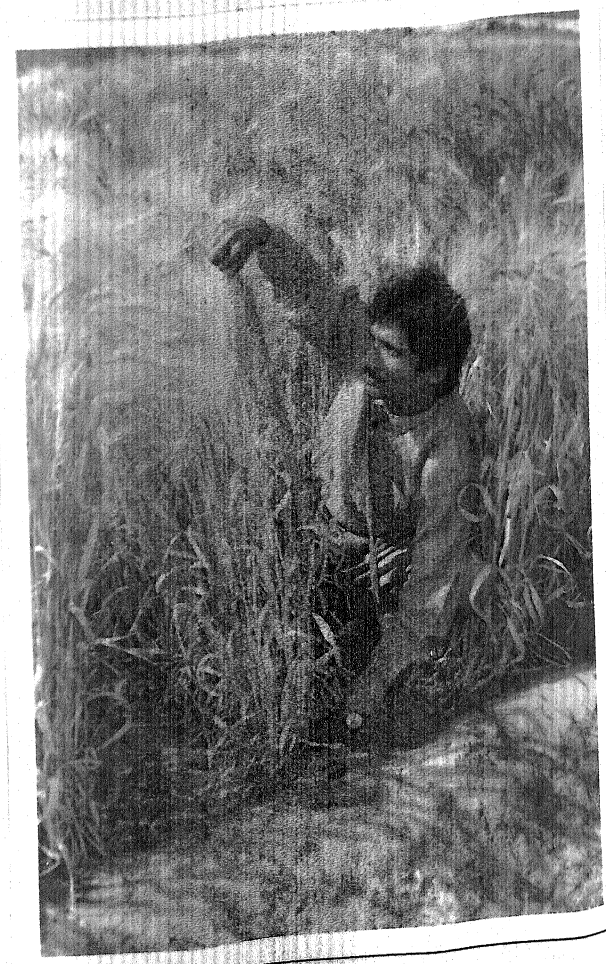
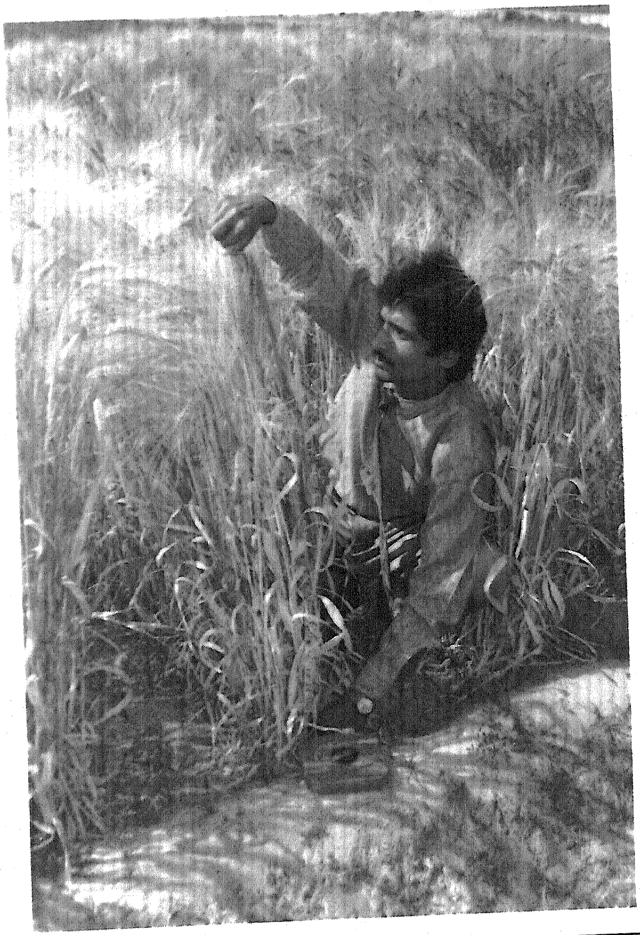
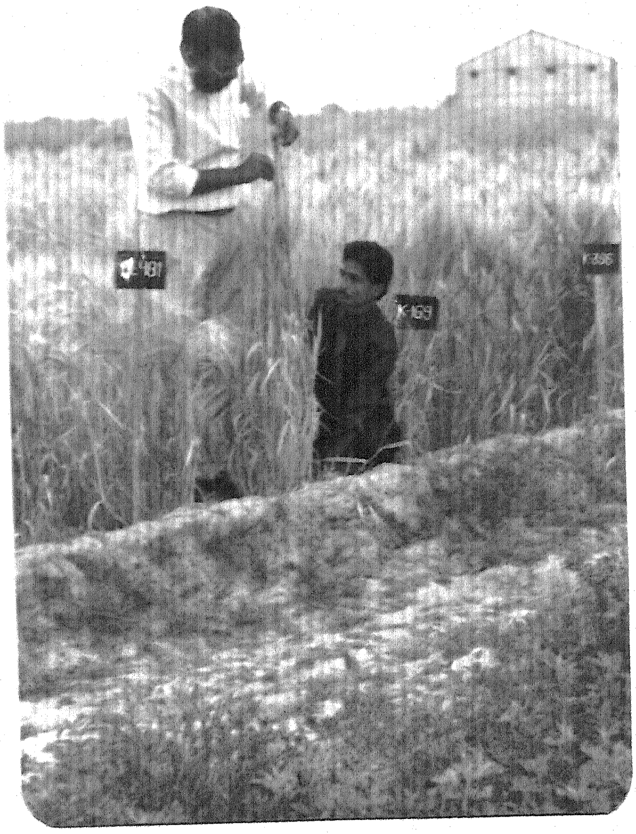
" " GUIDE - Dr. S.P. SINGH
DATE OF SOWING - 13-11-91
TITLE OF THESIS - A STUDY OF
GENETICS OF YIELD COMPONETS
IN BARLEY

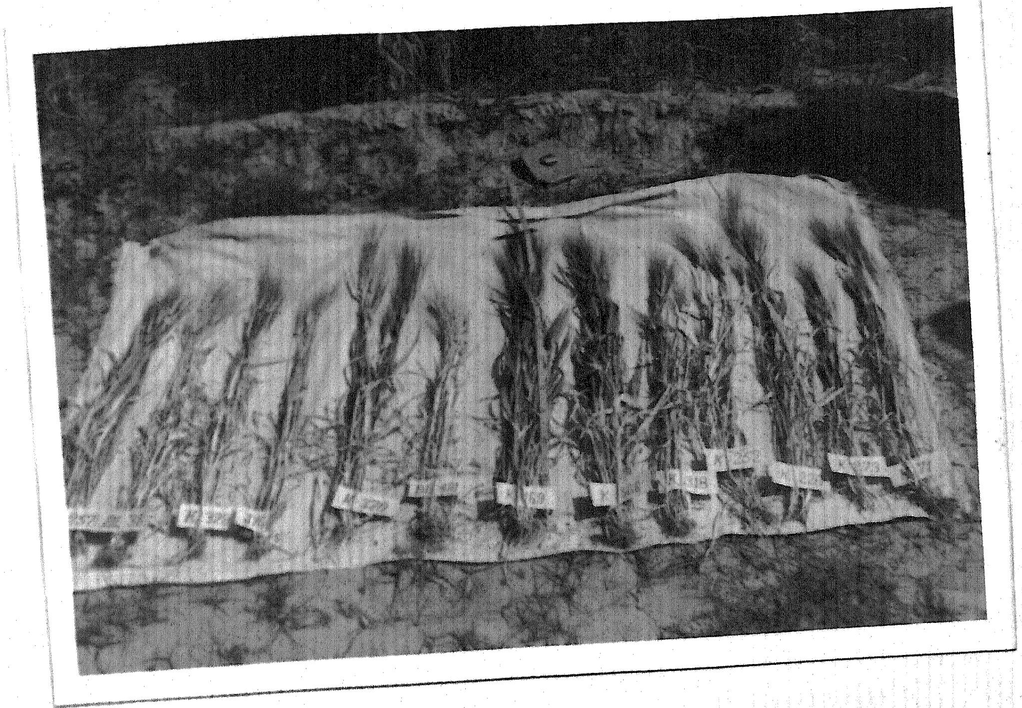


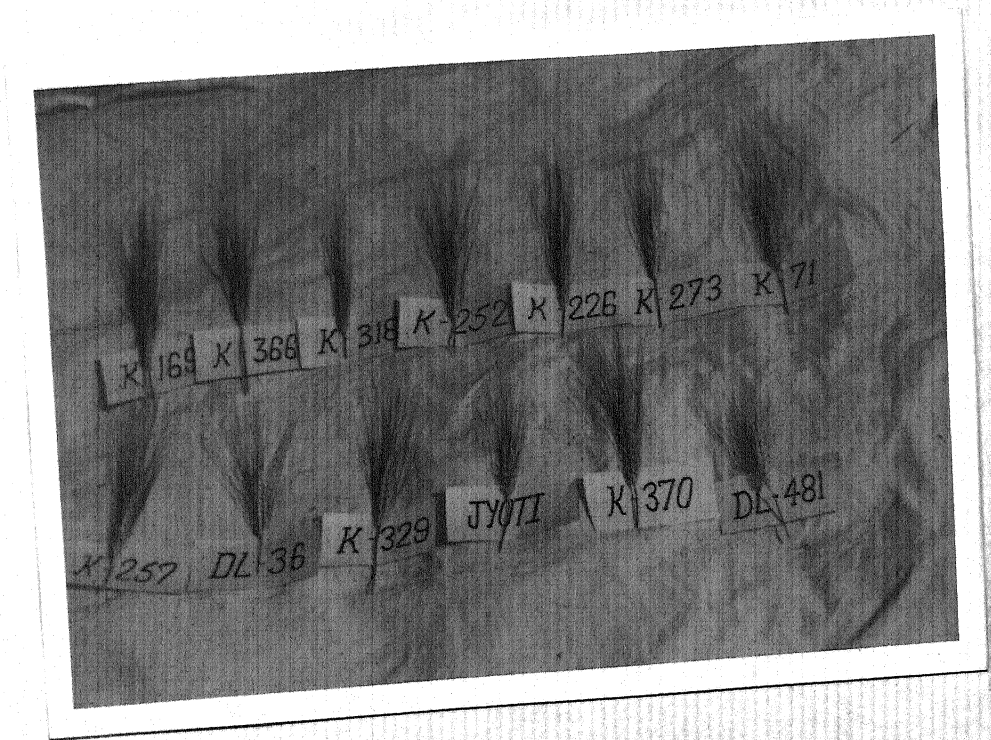





K-366
K-252



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K 366
K 318
K-252
K 226
K 273
K 71
K 257
DL 36
K-329
JYOTI
K 370
DL-481

CHAPTER - V

DISCUSSION

DISCUSSION

The main objective of any plant breeder is to evolve new varieties the existing ones. In the present investigation an endeavour has been adopted to select a better plant with the help of selection methodology, yield is a complex character in crop because it is related with so many characters but these are some characters which specially affect the yield. We call then yield contributing character's or yield components. We have some statistical and biometrical method to detect these characters upon which the selection can be made.

The genotypic as well as phenotypic variabilities of all the characters except days to maturity were found high which indicated that the selection method can be adopted for the emprovement yield in barley crop. On the whole the variability were found satisfactory.

Correlation study :

Height of plant, Days to maturity and 100 seed weight showed negative and significant correlation with yield were as number of tiller per plant, length of ear, No. of spikelet per spike and No. of seed per ear showed positive and significant correlation with yield.

Simarl findings has been reported by the following authors.

Tandon et al (1968)

Reported positive and significant correlation of yield with No. of tiller per plant and No. of seed per ear.

Sharma, (1970).

Found positive association of yield with No. of tiller per plant.

Sethi and Singh (1971)

Observed that grain yield was positively correlated with No. of seed per ear.

Singh et al. (1979).

Found Negative correlation yield and Day to maturity.

Prasad, C. et al. (1979)

Observed Negative correlation between hight of plant.

Path analysis study :

The direct effect of height of plant on yield was found negative with heigher magnitude then any other indirect effect whibh indicated that the negative correlation of this characters with yield was found due to negative high value.

The direct effects No. of tiller per plant on yield was found positive with high magnitude. The indirect effect via any other character's were lower then the direct effect.

The magnitude of direct effect of length of ear on yield was found positive and high. No. of other indirect

effects had higher positive value then the direct effect the positive correlation might had come due to this direct effect.

The correlation of No. of spikelet per ear with yield was found positive and significant but direct effect of this characters on yield was found negative so, positive correlation suddenly has come positive due to the indirect effect. The indirect effect of No. of spikelet on yield Vs No. of seed per ear and height of plant were found positive and high.

The direct effect of days to maturity on yield was found positive but the corrèlation value negative this negative correlation value might have come due to height of plant which has the negative and high magnitude of indirect effect.

The correlation of No. of seed per ear and yield was found positive and significant. The direct effect of number of seed on yield was also found positive.

100 seed weight was found negatively correlation with yield and direct effect was also found negative but the highest magnitude of negative effect was found via no. of seed per ear.

Residual effect indicated that the about 80% yield was contributed by the characters choosen in the present estimation.

On the basis path analysis there is no characters through which the direct xm selection can be done. Hence simultaneously procedure will be under which short statured early maturity plant which high number of tiller, long ear's and more seeded ear will be consider.

Heritability and Genetic advance :

Days to flower height of plant, No. of tiller per plant, length of ear, and No. of spikelet per ear exhibited high heritability percentage were as rase of the character were found with medium heritability. The genetic advance of all the characters on low. The high or medium haritability and low genetic advance indicated that the selection through their character's will be faithful for the improvement of the crop through selection breeding programme.

It is therefore suggested that early maturity, short statured long eared, more seeded ear and small seeded plant should be selected or the improvement of yielding ability of barley crop.

CHAPTER - VI

SUMMARY

SUMMARY

The present investigation, "A study of genetics of yield components in barley (Hordium vulgare L.)" had been started during the rabi season of 1991-92.

The seed of thirteen varieties of barley were obtained from Brahmanand Mahavidyalaya, Rath (Hamirpur) U.P. The material was sown on the farm of Brahmanand Mahavidyalaya, Rath, Hamirpur (U.P.) in Randomized block Design with three replications. It was sown on Nobember 13, 1991.

Thirteen varieties of Barley namely K-370, K-329, Jyoti, DL-36, K-257, K-71, K-273, K-226, K-252, K-318, K-366, K-169 and DL-481, were sown for the investigation. The data Viz.

Day to flower

Height of plant

No. of tiller per plant

Length of ear

No. of spikelet per spike

Days to naturity

No. of seed per ear

100 seed weight

Yield per plant had been recorded proper statistical method had been adopted for the following calculations.

1. Analysis of variance
2. To estimate genotypic and phenotypic variations

3. To esti..ate correlation coefficients
4. To estimate direct and indriect effect of different characters on yield through path analysis.
5. Heritability and genetic advance.

The genotypic as well as phenotypic variability of all characters except day to maturity were found high which indicated that the selection can be made through this characters.

The genotypic correlation of yield with No. of tiller per plant, length of ear, No. of spikelet per spike and No. of seed per ear were found positive and significant were as the yield was found negatively and significantly correlated with Height of plant, Days to maturity and 100 seed weight which indicated the real associationship of yield with the above characters.

The direct effect height of plant on yield was found negative with high magnitude. The indirect effects were lesser than direct effect Via any characters.

Similarly the magnitude of direct effect of No. of tiller per plant on yield was higher then any indirect effects.

The direct effect of length of ear on yield was found positive and high which is higher then any positive indirect effects.

The direct effects of No. of spikelet per spike on yield was found negative but the correlation found positive. It means the positive correlation might have come due to positive indirect effect. The higher magnitude positive indirect effect found via No. of seed per ear followed by Height of plant.

The direct effect of Days to maturity on yield was found positive but the correlation found negative which indicated that the negative correlation might have come due to height of plant and No. of seed per ear because of having higher megnitude of indirect effects in negative order.

The direct effect of No. of seed per ear on yield was found positive but the megnitude indirect effect via height of plant was found higher then direct effects.

The direct effect of 100 seed weight on yield was found not higher then the indirect effect via No. of seed per ear.

The heritability parsentage of high characters viz., Days to flower, height of plant, No. of tiller per plant, length of ear and No. of spikelet per spike were found high were as Days to maturity, No. of seed per ear, 100 seed weight and yield per plant sowed medium heritability.

The genetic advances of all the character were found low which indicated that the selection this characters

will be faithful.

The present investigations it has suggested that selection methodology can be adopted for the improvement varley crop. considering early maturity, small graind, short starchasd, more tillers, long dared more spikeleted and more seeded plant.

CHAPTER - VII

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CHAPTER - VIII

APPENDICES

APPENDICES

TABLES OF ANALYSIS OF VARIANCE

Table No. 1 : Anova for days to flower.

Source	D.F.	S.S.	M.S.S.	F
Replication	2	16.97436	8.48718	1.629
Treatment	12	950.35897	79.19658	15.203*
Error	24	125.02564	5.20940	-
Total	38	1092.35897	28.74629	

Table No. 2 : Anova for Height of plant

Source	D.F.	S.S.	M.S.S.	F
Replication	2	111.01590	55.50795	2.178
Treatment	12	1366.79641	113.89970	4.469*
Error	24	611.63744	25.48489	
Total	38	2089.44974		

Table No. 3 : Anova for No. of tillers per plant.

Source	D.F.	S.S.	M.S.S.	F
Replication	2	0.61744	0.30872	0.351
Treatment	12	78.89026	6.57419	7.472*
Error	24	21.11590	0.87983	-
Total	38	100.62359		

Table No. 4 : Length of Anova for

Source	D.F.	S.S.	M.S.S.	F
Replication	2	0.08681	0.04340	0.213
Treatment	12	18.64319	1.55360	7.625*
Error	24	4.88979	0.20374	-
Total	38	23.6179		

Table No. 5 : Anova for No. of spikelet per plant

Source	D.F.	S.S.	M.S.S.	F
Replication	2	0.64949	0.32475	0.279
Treatment	12	103.81294	8.65108	7.430*
Error	24	27.94364	1.16432	
Total	38	132.40608		

Table No. 6 : Anova for Days to maturity

Source	D.F.	S.S.	M.S.S.	F
Replication	2	1.58974	0.79487	0.248
Treatment	12	92.92308	7.74359	2.411*
Error	24	77.07692	3.21154	-
Total	38	171.58974		

Table No. 7 : Anova for No. of seed per ear

Source	D.F.	S.S.	M.S.S.	F
Replication	2	8.36794	4.18397	0.191
Treatment	12	593.60930	49.46744	2.255*
Error	14	526.44219	21.93509	
Total	38	1128.41943		

Table No. 8 : Anova for 100 seed weight

Source	D.F.	S.S.	M.S.S.	F
Replication	2	0.24347	0.12173	0.511
Treatment	12	6.66384	0.55532	2.329*
Error	24	5.72142	0.23839	
Total	38	12.62873		

Table No. 9 : Anova for yield per plant

Source	D.F.	S.S.	M.S.S.	F
Replication	2	9.55241	4.77620	0.339
Treatment	12	429.81183	35.81765	2.545*
Error	24	337.77386	14.07391	-
Total	38	777.13810		

Table No. 10 : Anova for Days to flower Vs Height of plant

Source	D.F.	S.P.	M.S.P.
Replication	2	38.23333	19.11667
Treatment	12	-570.25385	-47.52115
Error	24	- 15.10000	- 0.62917
Total	38	-547.12051	

Table No. 11 : Ancov for Days to flower Vs No. of tiller's per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	2.36410	1.18205
Treatment	12	-109.70256	- 9.14188
Error	24	14.50256	0.60427
Total	38	- 92.83570	

Table No. 12 : Ancov for Days to flower Vs length of ear per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	- 1.04359	- 0.52179
Treatment	12	-42.46744	- 3.53895
Error	24	2.98641	- 0.12443
Total	38	-46.49744	

Table No. 13 : ANCOV for Days to flower Vs No. of spikelet per plant

Source	D.F.	S.P.	M.S.P.
Replication	2	1.92538	0.96269
Tretment	12	104.32718	8.69393
Error	24	7.61128	0.31714
Total	38	113.86385	

Table No. 14 : ANCOV for Days to flower Vs Days to maturity

Source	D.F.	S.P.	M.S.P.
Replication	2	0.94872	0.47436
Treatment	12	-145.84615	-12.15385
Error	24	18.38462	0.76603
Total	38	- 126.51282	

Table No. 15 : ANCOV for Days to flower Vs No. of seed per ear

Source	D.F.	S.P.	M.S.P.
Replication	2	- 6.79538	-3.39769
Treatment	12	151.10538	12.59212
Error	24	24.93538	1.03897
Total	38	169.24538	

Table No. 16 : ANCOV for Days to flower vs 100 seed weight

Source	D.F.	S.P.	M.S.P.
Replication	2	- 1.08846	- 0.54423
Treatment	12	-23.92615	- 1.99385
Error	24	8.32846	0.34702
Total	38	-16.68615	

Table No. 17 : ANCOV for days to flower vs. yield per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	11.87128	5.93564
Treatment	12	71.38872	5.94906
Error	24	61.04205	2.54342
Total	38		

Table No. 18 : ANCOV for height of plant Vs No. of tiller per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	8.00359	4.00179
Treatment	12	-3.02462	-0.25205
Error	24	-11.85692	-0.49404
Total		- 6.87795	

Table No. 19 : ANCOV for height of plant vs. length of ear per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	-1.59972	-0.79986
Treatment	12	45.17262	3.76438
Error	24	15.45538	0.64397
Total	38	59.02828	

Table No. 20 : ANCOV for height of plant Vs. No. of spikelet per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	1.06054	0.53027
Treatment	12	-163.08808	-13.59067
Error	24	25.48246	1.06177
Total	38	-136.54508	

Table No. 21 : ANCOV for height of plant vs. days to maturity

Source	D.F.	S.P.	M.S.P.
Replication	2	-4.04872	-2.02436
Treatment	12	296.97692	24.74808
Error	24	65.61538	2.73397
Total	38	358.54359	

Table No. 22 : ANCOV for height of plant vs. No. of seed per ear

Source	D.F.	S.P.	M.S.P.
Replication	2	-27.16415	-13.58208
Treatment	12	-421.99431	-35.16619
Error	24	319.20215	13.30003
Total	38	-129.95631	

Table No. 23 : ANCOV for height of plant Vs 100 seed wieght

Source	D.F.	S.P.	M.S.P.
Replication	2	-4.53112	-2.26556
Treatment	12	-6.23658	-0.51971
Error	24	18.57812	0.77409
Total	38	7.81042	

Table No. 24 : ANCOV for height of plant vs yield per plant

Source	D.F.	S.P.	M.S.P.
Replication	2	21.16018	10.58009
Treatment	12	-234.82931	-19.56911
Error	24	235.96715	9.83196
Total	38	22.29803	

Table No. 25 : ANCOV for No. of tiller per plant vs length of ear per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.06456	-0.3228
Treatment	12	7.52108	0.6276
Error	24	2.16123	0.9005
Total	38	9.61774	

Table No. 26 : ANCOV for No. of tiller per plant vs. No. of spikelet per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.08431	-0.04215
Treatment	12	8.80262	0.73355
Error	24	4.50831	0.18785
Total	38	13.22662	

Table No. 27 : ANCOV for No. of tiller per plant vs Days to maturity

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.53333	-0.26667
Treatment	12	4.91795	0.40983
Error	24	3.66667	0.15278
Total	38	8.05128	

Table No. 28 : ANCOV for No. of tiller per plant vs. No. of seed per ear.

Source	D.F.	S.P.	M.S.P.
Replication	2	-2.22215	- 1.11108
Treatment	12	16.03113	1.33593
Error	24	-11.60651	- 0.48360
Total	38	2.20246	

Table No. 29 : ANCOV for No. of tiller per plant vs. 100 seed weight.

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.37531	-0.18765
Treatment	12	0.55762	0.04647
Error	24	-3.23269	-0.13470
Total	38	-3.05038	

Table No. 30 : ANCOV for No. of tiller per plant vs. yield per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	1.05318	0.52659
Treatment	12	75.78846	6.31571
Error	24	27.97415	1.16559
Total	38	105.81579	

Table No. 31 : ANCOV for length of ear per plant vs. Nol of spikelet per plant

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.21718	-0.10859
Treatment	12	19.88722	1.65727
Error	24	6.21824	0.25909
Total	38	25.88828	

Table No. 32 : ANCOV for length of ear per plant vs. days to maturity.

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.24487	-0.12244
Treatment	12	8.27872	0.68989
Error	24	-4.26179	-0.17757
Total	38	3.77205	

Table No. 33 : ANCOV for length of ear per plant vs. No. of seed per ear.

Source	D.F.	S.P.	M.S.P.
Replication	2	0.06017	0.03008
Treatment	12	42.32624	3.52719
Error	24	17.12043	0.71335
Total	38	59.50684	

Table No. 34 : ANCOV for length of ear per plant vs. 100 seed weight

Source	D.F.	S.P.	M.S.P.
Replication	2	0.00421	0.00210
Treatment	12	-2.62385	-0.21865
Error	24	0.21958	0.0915
Total	38	-2.40007	

Table No. 35 : ANCOV for length of ear per plant vs yield per plant

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.89810	-0.44905
Treatment	12	47.55061	3.96255
Error	24	2.15006	0.08959
Total	38	48.80257	

Table No. 36 : ANCOV for No. of spikelet per plant VS Days to maturity

Source	D.F.	S.P.	M.S.P.
Replication	2	0.92154	0.46077
Treatment	12	-37.46026	-3.12169
Error	24	-4.46821	-0.18618
Total	38	-41.00692	

Table No. 37 : ANCOV for no. of spikelete per plant vs No. of seed per ear.

Source	D.F.	S.P.	M.S.P.
Replication	2	0.78954	0.39477
Treatment	12	208.81627	17.40136
Error	24	24.30219	1.01259
Total	38	233.90801	

Table No. 38 : ANCOV for No. of spikelet per plant vs. 100 seed weight

Source	D.F.	S.P.	M.S.P.
Replication	2	0.15016	0.07508
Treatment	12	-13.29222	-1.10769
Error	24	0.80294	0.03346
Total	38	-12.33912	

Table No. 39 : ANCOV for No. of spikelete per plant vs yield per plant

Source	D.F.	S.P.	M.S.P.
Replication	2	2.08064	1.04032
Treatment	12	161.59261	13.46605
Error	24	24.53106	1.02213
Total	38	188.20431	

Table No. 40 : ANCOV for days to maturity vs. No. of seed per ear.

Source	D.F.	S.P.	M.S.P.
Replication	2	2.56615	1.28308
Treatment	12	-76.22436	-6.35203
Error	24	65.12051	2.71335
Total	38	-8.53769	

Table No. 41 : ANCOV for days to maturity Vs. 100 seed weight

Source	D.F.	S.P.	M.S.P.
Replication	2	0.45577	0.22788
Treatment	12	-3.26359	-0.27197
Error	24	2.08090	0.08670
Total	38	-0.72692	

Table No. 42 : ANCOV for Days to maturity vs. yield per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	2.04949	1.02774
Treatment	12	-55.77436	-4.64786
Error	24	94.15051	3.92294
Total	38	40.42564	

Table No. 43 : ANCOV for No. of seed per ear Vs. 100 seed weight.

Source	D.F.	S.P.	M.S.P.
Replication	2	1.42610	0.71305
Treatment	12	-30.14181	-2.51182
Error	24	17.56292	0.73179
Total	38	-11.15279	

Table No. 44 : ANCOV for No. of seed per ear Vs yield per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	-2.09546	-1.04773
Treatment	12	377.94043	31.49504
Error	24	159.87976	6.66166
Total	38	535.72473	

Table No. 45 : ANCOV for 100 seed weight Vs. yield per plant.

Source	D.F.	S.P.	M.S.P.
Replication	2	-0.29530	-0.14765
Treatment	12	-24.18108	-2.01509
Error	24	16.85918	0.70247
Total	38	-7.61719	

Table No. 46 : Mean value of different characters in barley

Characters Name of varieties	Days to flowers	Height of plant	No. of tillers per plant	Length of ear	No. of spikelete per spike	Days to maturity	No. of per ears	100 seed weight	yield per plants
K-370	71.667	112.267	5.4000	7.477	19.287	129.333	48.667	3.643	13.350
K-329	70.333	112.067	7.867	7.323	16.387	128.333	44.207	4.948	10.340
Jyoti	67.667	100.033	6.333	6.713	17.353	127.667	45.323	5.333	9.923
DL-36	70.000	97.000	6.733	7.133	19.633	124.333	93.610	4.507	16.830
K-257	70.667	106.333	8.333	6.233	16.307	128.333	43.900	4.537	12.703
K-71	64.667	112.667	6.800	8.513	19.230	129.667	49.857	4.532	13.370
K-273	75.333	104.000	5.733	7.430	18.510	128.333	51.613	3.960	13.273
K-226	63.000	112.133	8.400	6.677	18.247	130.000	49.403	4.408	11.667
K-252	72.667	108.533	4.000	6.927	17.927	127.333	47.417	4.907	9.203
K-318	80.000	105.733	5.000	6.153	18.433	127.000	44.173	4.473	10.233
K-366	76.000	104.233	4.733	6.433	18.397	128.667	52.657	4.458	13.040
K-169	65.333	117.067	6.533	7.967	17.523	130.000	46.747	4.613	16.290
DL-481	77.333	98.467	8.467	7.963	22.997	126.333	56.907	4.170	21.813